MACHINERY.

May, 1903.

SWAGING MACHINES AND THE COLD SWAGING PROCESS.

THE swaging process, although extensively used in certain classes of work is, as a machine shop operation, very little, if at all, recognized. The success, however, with which this process is employed for certain purposes would seem to indicate that its use might be applied with profit to a great class of work that is at present performed either by hot forging or by machining.

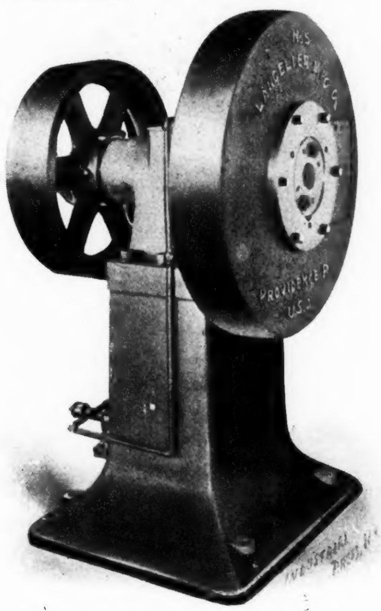


Fig. 1. Rotary Swaging Machine. (Langelier Mfg. Co.)

Cold swaging is the act of reducing or forming steel or other material while cold, such as drawing to a point or reducing the diameter of the work. This is performed by a machine which causes the work to be struck a great number of successive blows by a pair of dies of suitable shape to give the required reduction. The process is mainly applied to reducing wires, rods, and tubes, and is the only process by which rolled or plated stock can be reduced without destroying the plating or coating. For this reason it is largely used for jewelers' work, such as forming spectacle temples, fancy pins, and similar pieces. It is also extensively used for pointing rods or tubes which are to be drawn. It will put the best point known to wire drawers on a rod or piece of wire in a fraction of the time that would be required by any other method, and the same applies to its use on tubing. The millions of needles, bicycle spokes, button hooks, crochet needles, etc., which are turned out annually serve to show some of the possibilities of the swaging process.

As an illustration of the saving of stock that may be accomplished by the use of this process, we will consider a simple piece of rod which is tapered from full diameter to a small point, as shown in Fig. 3. In the view of the piece marked *A*, the dotted lines show the original piece of stock from which it would be made if the work were done on a lathe or screw machine, by the machining process, the dotted section showing the amount of material that would be wasted. In the lower view, *B*, the dotted lines show the amount of stock that would be required to produce it by the swaging process and there would be no waste whatever.

What were, without doubt, the original swaging machines were used in the Naugatuck Valley of Connecticut some time previous to the '60s, one of them at the works of Wallace & Sons, at Ansonia, and the other at the works of the Benedict & Burnham Mfg. Co., at Waterbury. The machine at the first named place was the design of Mr. George Doolittle, now deceased; while the latter was the work of Mr. George Somers, now president of the Bridgeport Brass Co. These devices were very simple, hardly rising to the dignity of machines, and were used as attachments to lathes. A block containing the stationary or bottom die replaced the tool post in an engine lathe. The top or reciprocating die was placed in the end of a lever whose opposite end was fulcrumed to a projecting arm of the block which carried the stationary die. A shaft with tappets on its periphery was mounted between the centers of the lathe and served to drive the end of the lever down, while a spring was used to throw it up after the blow had been struck. A stop was arranged to limit the upward motion of the lever. It will be seen that as the driving shaft was rapidly revolved, the arrangement presented a means for the bringing together and drawing apart of the dies in a rapid succession of blows. In one place this device was used to form a peculiar shape of cartridge shell, and in the other shop it was used for pointing the tips of lightning rods.

About 1860, two shopmates, O. L. Hopson and H. P. Brooks, invented a wire buckle. How to point the tongue of this buckle, became a problem with them and they began by the very obvious method of striking between dies which made the point; but the superabundant metal was thrown out in a flash or wing, at the joint between the dies, and these flashes had to be subsequently cut off. This led to a discussion of the possibilities of swaging a point by a succession of compressions, each so slight as to produce no flash or fin. Their first machine, a crude affair, was successful in its operation, and like many other inventions, it opened the way to a considera-

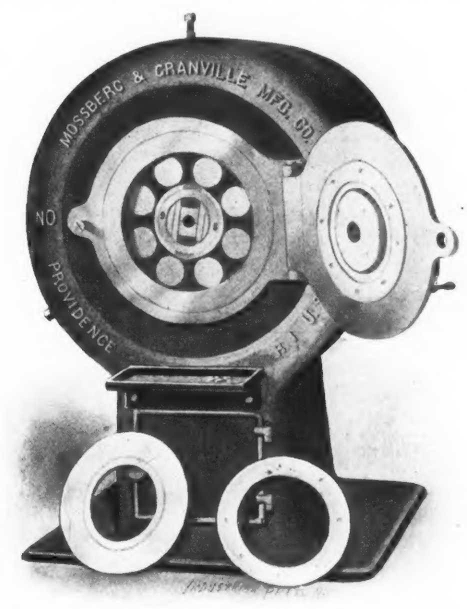


Fig. 2. Rotary Swaging Machine, showing Dies and Rolls. (Mossberg & Granville Mfg. Co.)

tion of adapting the new principle to other uses. This called for improvements in the devices for forcing dies together, and Mr. E. J. Manville, a noted inventor, was called upon to devise improved means for producing the succession of compressions which, up to this time, had been accomplished on the trip hammer tappet principle and had been found objectionable on account of too great wear upon the parts. Mr. Manville happily hit upon the use of swinging cams, or detached toggles,

For the historical portion of this article we are indebted to Mr. S. W. Goodyear, of Waterbury, Conn., and for the description of the horizontal swaging machine to Mr. W. D. Pierson, of the Waterbury Machine Co. The Langelier Mfg. Co. and the Mossberg & Granville Mfg. Co. have also assisted in its preparation by contributions of photographs and samples.

which, when the dies were driven together, constituted with them, as engaged in alternate pairs, the well known and powerful device, the knuckle joint. Here was a means of avoiding the use of the objectionable tappets and of putting the pressure required, really a crushing force, upon a good, broad concavo-convex surface capable of standing up under the pressure.

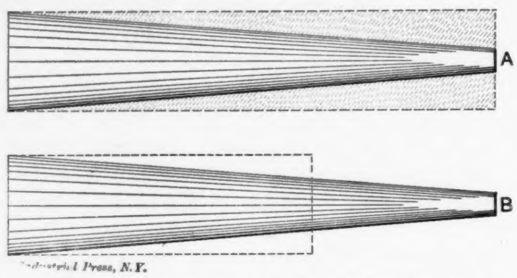


Fig. 3. Diagram Illustrating Saving of Stock by the Swaging Process.

The Hopson and Brooks machine, with the Manville improvements, soon came to the front as the machine *par excellence* for pointing rods and wires for drawing, finding its way into the wire mills for that purpose, as well as for use in many lines of industry in which articles of metal require to be reduced, tapered, or pointed, such as taper dowel pins, button hooks, marking awls, needles for sewing and knitting

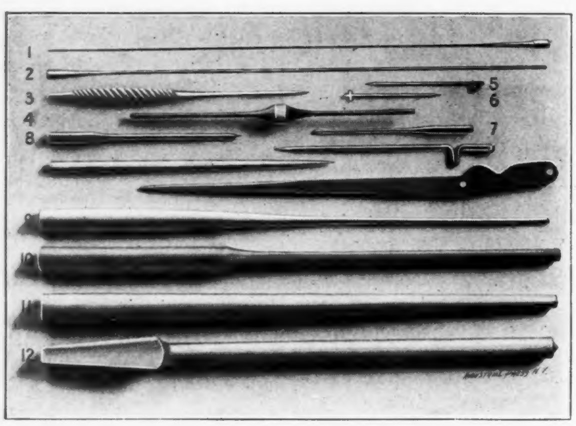


Fig. 4. Samples of Work Done with the Rotary Swaging Machine.

1-2. Spectacle Temples (Steel).
3. Fancy Pin (Rolled Stock).
4. Ring Body (Plated Stock).
5-6. Pin Tongues (Steel).
7-8. Machine Needles (Steel).
9-10-11. Cotton Machine Spindles (Hard Steel).
12. Bitt (Steel).

machines, and kindred articles. A very important field which the swaging machine occupied in its early development was that of furnishing the means for the production of drill rods to take the place of the well-known and justly-celebrated bright steel rods used for taps, drills, reamers, etc. This manufacture of American drill rods, beginning in 1867 by the use of

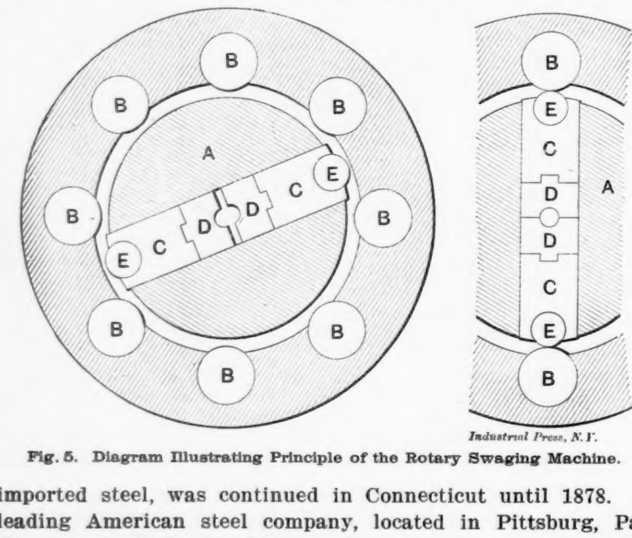


Fig. 5. Diagram Illustrating Principle of the Rotary Swaging Machine.

imported steel, was continued in Connecticut until 1878. A leading American steel company, located in Pittsburg, Pa., then acquired the machines and patents and at once commenced the production of real American drill rod from their best special steel, an industry which is still continued and increased to very large proportions.

From these early developments swaging machines have come to be one of the recognized factors in mechanical production. They are now built upon two entirely different lines, i. e., those having the dies mounted in a revolving head, called rotary machines, and those having the dies mounted in slides, working horizontally, called horizontal machines. We will consider the construction and principle of the machines of each of these classes.

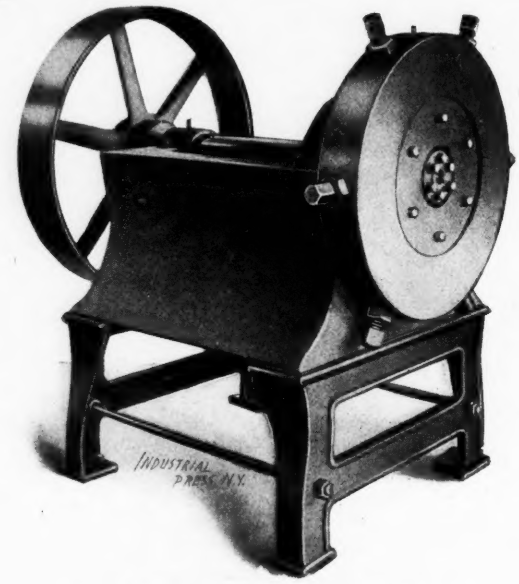


Fig 6. Goodyear Rotary Swaging Machine.
Waterbury Farrel Foundry & Machine Company.)

Rotary Swaging Machines.

The rotary swaging machine is now being made by a number of manufacturers, and while the details of the different machines vary in some respects, the principle is the same throughout. Representative machines, made by several of the swaging machine builders, are shown in Figs. 1, 2, 6, and 7.

The principle of the modern rotary swaging machine is shown in the line drawing, Fig. 5. Inside of the head in

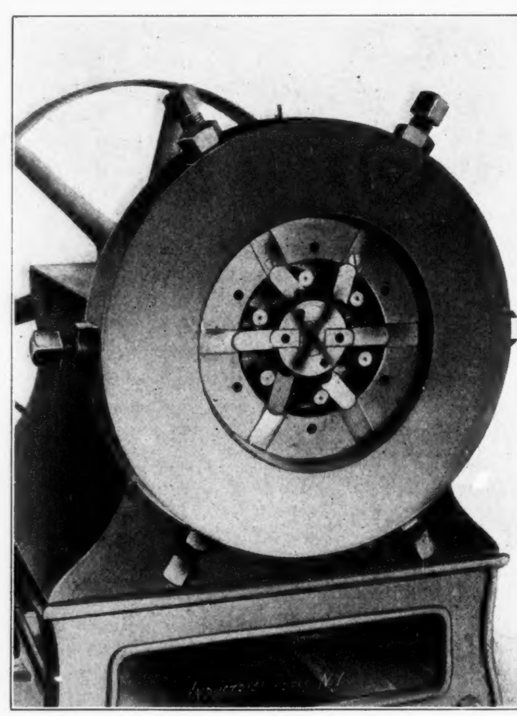


Fig. 7. Goodyear Rotary Swaging Machine, showing Arrangement of Dies and Toggles.

which the spindle revolves is a set of hardened steel rollers, *BBB*, which are fitted in recesses in the fixed casting, each of them being free to run on its own axis. The front end of the spindle *A* is large and has a slot across its face in which the hammer blocks slide. These have recesses in their inner ends for holding the dies, *DD*, and in their outer ends are the rolls, *EE*, which are free to turn when they come in contact with

those in the head. As the spindle revolves and the rolls in the die blocks are brought into contact with those in the head, the dies are forced together onto the stock. After passing a set of rolls, the dies are thrown apart by the action of centrifugal force, which keeps them separated until the next set of rolls is encountered, when another blow results. The machines are run at a spindle speed of from 400 to 500 revolutions per minute, and as there are eight rolls in the head, the result is from 3,200 to 4,000 blows of the die per minute. The work in these machines is not rotated, as the rotation of the spindle distributes the blows evenly around the circumference of the piece being operated upon. In the type of machine shown in Fig. 7, the rollers are replaced by oscillating cams which, when they come in line with the ends of the die blocks, form a powerful toggle joint and bring the dies together with great force. Adjustment is provided for by means of a series of set-screws which cause the wedges back of the cams to slide in toward the center. Some samples of the work done with the rotary machines are shown in Fig. 4.

Horizontal Swaging Machines.

The horizontal swaging machine was originally designed by Mr. John Henderson, of Waterbury, Conn., and the first machines were built by him. Later the manufacture was transferred to the Waterbury Machine Co., by whom this type of machine is now manufactured. The horizontal machine is especially designed for work of a heavy nature, such as is encountered in mills where rods and tubing are manufactured. It is constructed on an entirely different principle from the rotary machine. Fig. 8 shows a machine of this type. The round hole at the left, in line with the upper bearing, is the opening where the work is introduced. The center of this

Fig. 8. Horizontal Swaging Machine. (Waterbury Machine Co.)

hole marks the place where the dies are split on the vertical line. One-half of the die is backed up directly against the heavy casting of the frame, and the other half, toward the bearing, has a reciprocating motion on the horizontal line. The means by which this motion is obtained will be seen by reference to Fig. 9.

The lower main shaft *A* carries the balance wheel and has a crank of short throw between the bearings, while the upper shaft, *B*, of large diameter, has a crank with a throw about six times as great. A connection *C* joins these two cranks, and it will be seen that if the lower shaft makes a complete revolution, it will turn the upper shaft through but a portion of the circle. If a line be drawn through the center of this upper shaft, so that it is horizontal when the shaft is in the middle portion of its turn, it will follow that this shaft will have a rocking motion about its center, and the diametrically opposite points where this line meets the periphery of the shaft on either side will each pass the center twice for every revolution of the pulley. If, now, a system of horizontal toggles be interposed between the reciprocating block and the frame casting at the right, in which system the middle block passes through the shaft, it will follow that by the rocking motion of this block the distance between the extreme ends will increase and decrease twice per pulley revolution, or, in other words, the number of blows will be twice the speed of the pulley. A spring, not shown in the cut, is used to separate the dies between the blows.

These machines reduce rods up to 2⅝ inches in diameter and tubes up to 4 inches, the amount of reduction ranging from ⅛ to ¼ inch for rods and ⅛ to ½ inch for tubes, depending upon the diameter and nature of the material. Where a much greater reduction is required than can be made by passing the work once through the dies, it has proved a great conven-

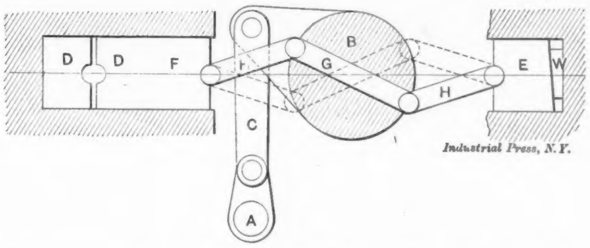


Fig. 9. Diagram illustrating the Principle of the Horizontal Swaging Machine.

ience to use a machine with three sets of dies, which gradually decrease in size. This is brought about by lengthening the machine out at the left hand end for two extra pairs of dies, and as but one pair is in use at a time, the motion is transmitted from one set to the other, all having a sliding fit in the opening. The form of the die is a cube, so that four faces may be used, as required, the dies being turned around to bring similar half openings together. When small diameters are required several sizes can be cut on each face, and the changing from one size to the other is but the work of a moment.

While the machine is principally designed to point rods and tubes for subsequent drawing through dies, it has numerous other uses, such as flattening round stock to a desired shape without waste of material. In this line it has been successfully applied to shaping ends of rods for screw driver blades, the round rod being merely pushed into the opening and the finished article withdrawn without any fin or waste. Many other operations of a similar nature may be performed, and in this class of work it covers a ground not practicable with any other type of machine.

* * *

The *Scientific American* describes an experiment to test the possibilities of propelling an ice boat by means of a rotary fan driven by a gasoline engine. The craft consisted of a platform 12 feet long by 4 feet wide, supported on runners and provided with a seat for the steersman. The boat was guided by a pair of ordinary bicycle handle bars while the levers for controlling the spark, the mixture and clutch were within easy reach.

The propeller, which is 4 feet in diameter, is mounted on a frame above the motor, which is a 2¾ horse power de Dion, connected with it by sprocket and chain. Its four blades are inclosed at the periphery by a flat band of their own width, riveted to them. This outer rim and the shape of the blades or pitch of the screw, are vital features of construction.

When the motor is started at slow speed and the clutch is thrown in, the propeller begins to revolve slowly, and gradually gains headway. As soon as it has attained a certain velocity of revolution, the sled starts slowly and gains speed, along with the propeller.

Only one model has been made, but this was successfully tested, and carried three full-grown persons at a rate of fifteen miles an hour. The inventor believes that a machine with twin propellers, operated by two 10 horse power motors, would easily make two miles a minute. At the trial the weight of even six passengers did not affect its speed. It seems to run just about as fast across or into the wind, as against it; but when it goes into the wind, the number of revolutions increases and the motor runs faster.

SHOP CONSTRUCTION.*—8.

POWER.

OSCAR E. PERRIGO.

In considering the question of power and its transmission to the different points in the plant where it will be required, we are confronted by a rather complex subject, and one which has been much discussed by many competent engineers in nearly all the mechanical journals during the past few years. The various methods and theories have had able champions in the special line in which they have been interested and rival claims have been ingeniously advocated to prove that they were the best methods to be adopted for nearly all conditions. One class have proven, to their own satisfaction at least, that while electricity is still in a very imperfect state of development and generally very imperfectly understood by a large majority of mechanics, it is to be the coming power for all purposes and may be used under nearly all conditions. Many of these claims have been well substantiated and the fact is that to-day there is a far greater and more general use of electricity in transmitting power than was thought possible even ten years ago. The ultimate limit to its usefulness no one can foresee. Again, the advocates of compressed air have shown that this has many advantages as an easily-transmitted and very useful power, and in its special sphere is doing very efficient and admirable work. New applications are constantly being found for it, and many operations formerly performed by hand are very much quicker, cheaper and better accomplished by its use. The sphere of its usefulness has broadened very much in the last few years and now we find it in nearly all up-to-date shops, for a large variety of purposes. In this it does not take the place of electricity, but rather is used in conjunction with it, or with steam power for the purpose of providing the compressed air, as may be most convenient.

The old-time mechanic is, however, apt to "pin his faith" to shafting and belts as the most reliable method of transmitting power, perhaps because he is better acquainted with this method; while the younger men are prone to argue the efficiency of rope transmission as the proper method. Many examples of efficient service by rope transmission might be cited, yet for the general purposes of a machine shop it is doubtful if it will ever replace leather belting. Recently the utility of transmission by chain has been revived and the interest in the subject very much increased by the improved forms adopted by later inventors. It is often exceedingly useful for the transmission of power within the limits of a single machine, formerly for operating feeds, and later for transmitting the principal power of the machine. Properly constructed, this system would seem to have a broad and practical field of usefulness in the future.

But all of these methods and systems, when reduced to the plane of practice in providing for the power plant of manufacturing concerns, are simply so many different methods of transmitting and distributing power, since it is to water or steam that we must look for our original power. We are confined, then, to these two sources of power—water and steam—and where the location does not provide us water power we must accept steam. Assuming the latter conditions in our manufacturing plant we must provide for steam as our source of power.

This having been settled, the best means of transmitting the power to the machines on the ground floor of the machine shop, to those on the gallery floors, to those in the tool room and pattern shop, and to the forge shop, foundry and carpenter shop, must also be considered. The question of boilers will naturally come first, and, in this connection, the type best adapted to the work; also the best method of setting them to produce the most efficient results. Next, the type and the dimensions of the engine, and the manner of its connections. And lastly, the method of transmitting the power to the machines to be driven.

In arranging our power plant we begin with the boiler room. We shall need a working capacity of at least 500 horse power. This may be distributed in a battery of boilers of 100 horse power each. One extra boiler is added so that in case of an accident to one of them, necessitating repairs, five of them may still be in proper working condition. Four of these boilers will be needed to run the engine, which leaves a margin of 100 horse power with which to supply the necessary steam for other purposes about the plant. Under ordinary conditions a sixth boiler may be added, giving 200 horse power for these purposes. By this arrangement there is the additional advantage that the boilers may be cleaned one at a time without shutting down the power.

The styles and types of boilers in the market are many and various, and most of them have good and practical claims to consideration in one way or another. But it is somewhat doubtful if any type will be devised that will become as popular for general use—or in the long run any more efficient and economical for hard, every-day service—as the return tubular type. Ofttimes the space in which the boilers must be located will determine the type, whether they shall be upright or horizontal; and the method of firing them, as well as the kind of fuel to be used must be taken into consideration. Mechanical stoking is used with success in some instances, but as yet has not come into general use. Both oil and natural gas as a fuel are much used in such localities as render them more economical than coal.

Our boilers will therefore be of the return tubular type, fired by hand, with the usual kind of soft or bituminous coal. They will be 66 inches diameter and 16 feet long, exclusive of the curtain sheet under the space occupied by the "up-take," or smoke connection. The arrangement for setting the boilers is shown in vertical, longitudinal section in Fig. 1; in a half vertical cross section, and half front elevation in Fig. 2, and in a horizontal section above the grate line in Fig. 3. There are several matters in connection with the setting of boilers which should be strictly attended to. Among these are the following: Two courses of bricks should be laid above the floor line of the boiler room for the boiler fronts to rest upon; the top course at least should be headers, and carefully leveled up. They should be so located that at least two inches will project in front of the boiler fronts. The ashpits should be cemented so as to allow of the introduction of a few inches of water. The front supporting brackets rest fairly upon iron plates in the side walls, while the rear brackets rest on rollers, which in turn rest on the iron plates set in the walls, by which arrangement all expansion of the boiler is toward the rear. The brickwork around the brackets should be entirely clear of them so as to leave the boilers opportunity to expand and contract without injury to the walls. The grates should incline from front to back from ¼ to ¾ inch per foot. The bridge wall should come up to within 12 or 14 inches of the bottom of the boiler, and be curved to suit its form, although this is not absolutely necessary. The width of grate surface should be equal to the diameter of the boiler. The side walls of the furnace are to incline outwards, so as to be two inches from the sides of the boiler, at a point one course of bricks below the bottom of the brackets. The fire bricks should be laid with a header course every five courses, so that burned-out bricks may be conveniently replaced. At each side of the fire doors cast-iron "cheek-pieces" should be put in, the cast-iron arch plate over the door resting on them. These "cheek-pieces" should be about 1¼ inches thick, of the form shown in Fig. 3, and have as many half-inch holes cored in them as possible, the holes spaced two inches from center to center, for an air supply to prevent them from burning out. Their height is equal to the height of the fire door at the side. They will be found to be very durable and to save much expense in fire brick repairs. They may be removed and replaced whenever the furnace is cool, by jacking up the arch plate a trifle and letting it down on the new "cheek-piece" introduced. Their inclined form renders the cleaning of the fire more convenient and the extreme front corner which they cut off is of little benefit in making steam.

Both outside and division walls should have a two-inch air space, as shown. The top of the boiler should be covered with asbestos, or with a brick arch. If the latter, there should be a two-inch air space left between it and the boiler. The boilers must rest only on the supporting brackets and in no case on the boiler fronts. The fronts are held in place by

* This concludes the present series, but another series by the same author, on shop equipment, will be published later.—EDITOR.

anchor bolts ¾ inch in diameter and four feet long, with the inner ends bent to a right angle 10 or 12 inches long. Their front ends are threaded for nuts coming outside of the boiler fronts, so that a defective or cracked portion of the front may be readily removed and replaced without disturbing the brickwork.

The smoke connections from the boilers to the stack may be the same width all the way through, in which case its height is to be increased from the first to the sixth boiler to include the additional area necessary for each boiler as it progresses toward the stack. Thus it may be 36 inches wide and 20 inches high at the first boiler, and increasing to 78 inches high at the sixth boiler. It will perhaps be more convenient to increase also the width in order that the area at the large end may equal that of the stack without increasing the height to such an extent. By this method we may make the larger end 48 inches wide and 60 inches high. There should be a cleaning door in the end of the smoke connection at the first boiler, and a pivoted damper properly balanced between the sixth boiler and the stack. It will be convenient also to have dampers in the "uptake" from each boiler to the main smoke connection, so as to shut these off whenever a boiler is laid off for cleaning or repairs.

The steam connections from the tops of the boilers are to be so arranged that any one or more of the boilers may be "cut out" and the use of all the others continued. All steam pipes of three inches or over should be covered with an efficient and lasting non-conducting material. That containing a large portion of asbestos will probably be found the best.

The foundations for the boiler settings should be prepared in the same manner as for a machine foundation, as described in the article in the January number, due consideration being given to the weight to be supported, say about 1,200 pounds per square foot. The plan of boiler settings shown, that is, supporting the boiler on brackets attached to it, is the ordinary method. The more modern method, however, is to erect iron columns at each side of the boiler and upon these to lay I-beams, from which the boiler is suspended by iron rods, entirely clear of the brickwork, and with no part resting upon it. While this plan is no doubt correct in theory and practice, it is considerably more expensive than the method shown herewith and for that reason it may not receive the favor it deserves.

The general plan and arrangement of the boiler room with the boiler settings, the smoke connections with the stack, the coal-delivering tram track, scales, etc., and the engine room, with the location of the engine and its connection with the main shaft, is shown in Fig. 4, and in so far as it relates to the boilers and settings it is substantially the system adopted by the Bigelow Company, New Haven, Conn. As to the engine, it seems fairly well conceded that for economy of steam and general efficiency in furnishing the power for machine shop work the horizontal, cross compound condensing engine will be the best. This type of engine is made by a number of well-known engine builders, and while all of them have certain convenient features and peculiarities of design and construction which commend them to different purchasers, it is probable that there is no very great difference in their efficiency or economy in the general results.

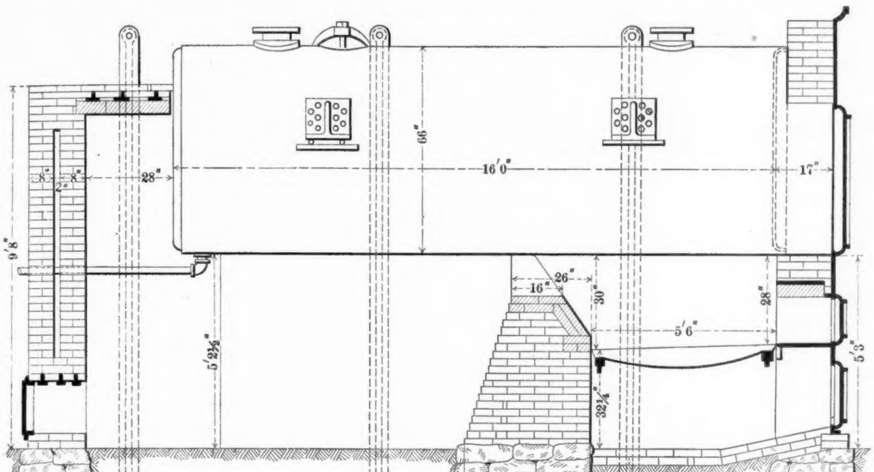


Fig. 1

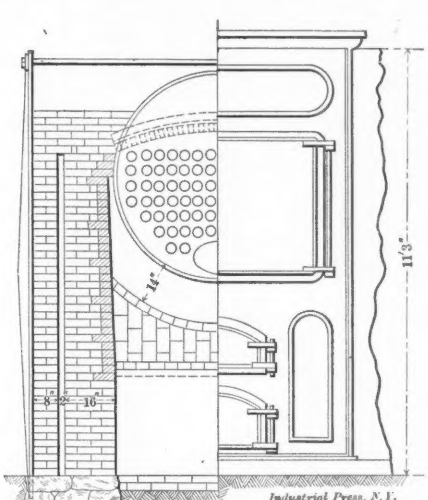


Fig. 2

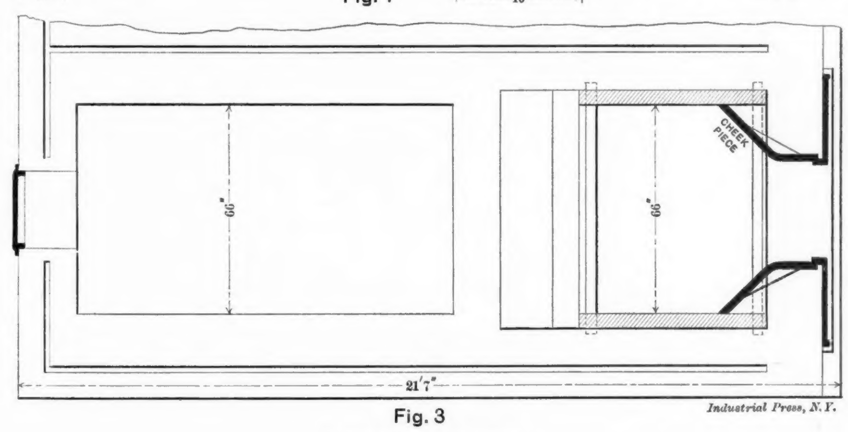


Fig. 3

Boiler and Boiler Setting.

The subject of gas engines has not been considered in connection with our plans as they do not seem suitable where a large amount of power is required, whatever may be their advantages in small or isolated plants.

Prominent among the builders of steam engines of the type referred to above are the Allis-Chalmers Company, of Milwaukee, Wis., and the William A. Harris Engine Company, of Providence, R. I., and it is this type of engine which is illustrated and described in this article, and commended for machine shop use. The size selected may be 16 and 32 x 48 inches, or 18 and 36 x 42 inches, with a balance wheel 18 feet in diameter with a 36-inch face, and capable of generating 400 horse power at 80 revolutions per minute and steam at 125 pounds pressure.

It will be proper to consider whether to drive direct from the engine to the machines by means of shafting and belts, or whether the engine shall drive dynamos, from which the electric current may be transmitted by proper conductors to motors, which in turn may drive main lines of shafting, or to a number of motors located in different parts of the works, driving short lines of shafting operating groups of machines, or again, whether we shall place a small motor upon each individual machine to drive it. All of these methods have their peculiar advantages and necessarily their disadvantages, corresponding to the conditions, the positions of the machines to be operated and the duty that is to be performed. Again we may profitably make use of compressed air for some of our work, as for instance, for drawing patterns, turning flasks and other portions of the lighter work of the iron foundry, as well as for the chipping room where hand chipping tools so operated are very convenient and useful. Hammers operated by compressed air may be used

in the forge shop, since this force may be transmitted long distances with practically no loss such as steam is subjected to by condensation, and electricity by loss of electromotive force. Various operations in the machine shop also may render a supply of compressed air very desirable. This matter will be governed to a considerable extent by the kind of work to be done, or kind of machinery to be built.

It would seem best in theory as well as practice, and most efficient and economical, to avail ourselves of whatever good points each method possesses for the particular case in question, and, by using any of the different systems where the conditions are most favorable for its employment, to make the most of the useful and practical features and avoid as many of the difficulties and disadvantages as we may be able. For instance, while the practice of driving individual machines by separate motors may be said to be yet in its infancy, enough has been already done to prove its advisability in many ways, and to show that planers from 40 inches upwards may be profitably driven in this manner. The same may be said of lathes from, say 36 inches upwards, and also of the larger radial drills, vertical milling machines, boring mills, and, in fact, of most of the heavy machine shop tools. At the same time it does not appear to be as efficient or practical to apply individual motors to small machines when a group of them may be conveniently driven from a short line shaft run by one motor. The question of friction of the two systems of transmitting power, that is, from the engine by shafting and belting, or the loss of power by generating an electric current with which to drive motors, is one which has provoked much discussion. Probably it will be found in practice to be about as follows: Where the distance is short, shafting and pulleys are much the more economical. For distances of two or three hundred feet there will be little difference in the two systems. For much greater distances the advantages are in favor of the electric method.

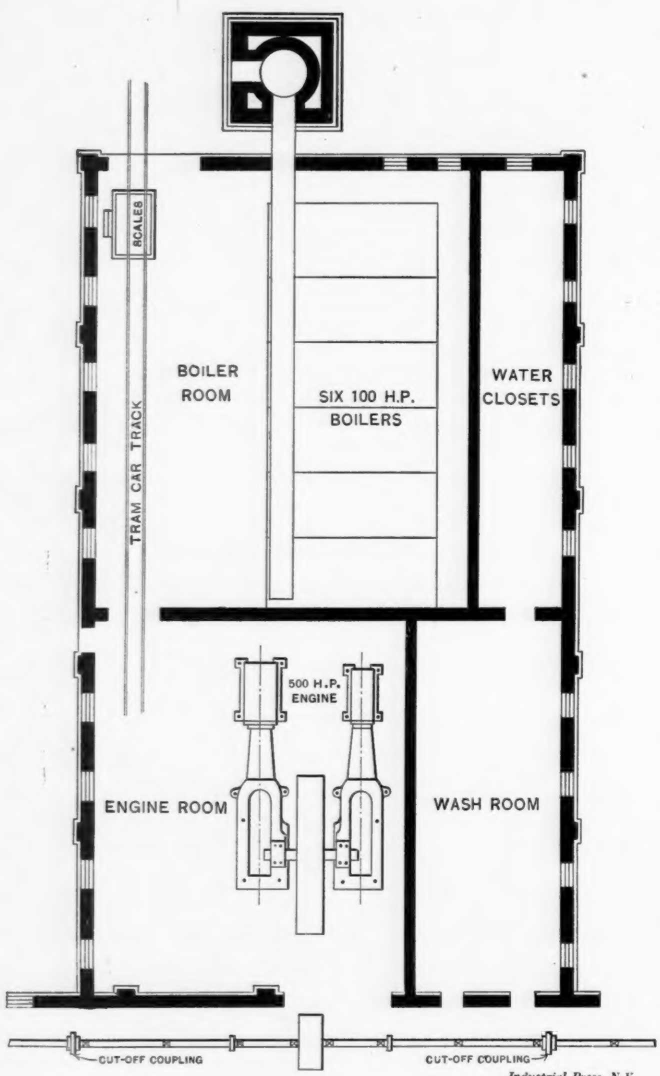


Fig. 4. Plan View of Power Plant.

The plan of power transmission here selected is to drive from the balance wheel of the engine to a 72-inch pulley on the main line of shafting, giving a shaft speed of 240 revolutions per minute. This shaft is in lengths of 20 feet, supported by hangers every 10 feet, and with a hanger on each side of main driving pulleys. The three lengths in the center are five inches in diameter and the remaining portion each way from these three lengths is 3½ inches in diameter to the end. Cut-off couplings are provided on the main shaft at the points shown in the drawings, for the purpose of stopping either section of the shaft in case of accident. In the same manner, the shaft in the gallery over the main line has a cut-off coupling at each end of the section, upon which the main pulley is located. Shafting is frequently made at the present time on the odd sixteenth of an inch diameter, but the even sizes are here given for convenience. The shafts are provided with roller bearings, and all pulleys with the exception of the large main driving pulleys are of the pressed sheet steel form, as being the lightest pulley made for strength, convenience and transmission of power. From the end of the main shaft toward the front of the building, power is taken for the machines in the tool room. From near the center, power is carried by a vertical belt to the gallery floor above. This shaft is 3½ inches in diameter for the central 20-foot length and the remainder is three inches in diameter. Upon the central length, as well as on the main line below are pulleys 48 inches in diameter and 14 inches face. The central length is supported by four hangers—one at each end, and one on each side of the main pulley. In all cases the couplings are to be placed on the side of the hanger away from the source of power, so as to be secure in case of the failure of a coupling.

The dynamos for lighting, as well as those for driving the motors may be located in the engine room and driven by belts from the main line by friction pulleys, or they may be located under the main line shafting. It should be remembered that for a belt of high velocity it will be much better to run it horizontally than vertically, and that it will transmit much more power under the former condition. If it is desired to locate the dynamos in the engine room and run them by horizontal belts, a countershaft may be located near the floor, just inside the engine room and driven by a belt from the main line.

An independent engine may be used to drive the motors. In this case the power of the main engine would be considerably reduced. The main line shaft furnishes power for all machines on that side of the main floor. The machines on the opposite side of the main floor may be those which it is desired to drive by individual motors, while in the gallery above, the line shaft, in, say three or four sections, may be driven by suitable motors. The same method may be desirable in the pattern shop and also in the tool room, if preferred, although it is more adaptable in the pattern shop where power is not used continuously. The power for driving the machines in the carpenter shop may be transmitted by belt from the main line through a belt box occupying the space between the machine shop and the carpenter shop to the line shaft in the latter. Or, a motor may be located in the carpenter shop.

If a steam hammer is used in the forge shop the steam supply should be carried in a pipe passing through an underground brick conduit, as carrying it around through the machine shop and carpenter shop would necessitate a long line of piping. A motor will be most convenient for operating the blast fan, drop hammers, cutting-off machines, power hack saws, etc. For the foundry, steam may be carried under ground, across the yard in a brick conduit, as the most direct way, to the engine running the heating apparatus, and another for the cupola blower and the tumbling barrels. Here again motors will be very convenient, as one may be directly connected to the heating apparatus fan and another used for the cupola blower and the tumbling barrels, as well as to run the elevator which supplies the cupola platform with its fuel and stock.

MANUFACTURING ARMATURE DISKS AND SEGMENTS.

JOSEPH V. WOODWORTH.

The adoption and use of dies, power presses and special sheet-metal working machinery for the economic production of parts of electrical apparatus has had great development during the past few years; so that to-day establishments that manufacture sheet-metal working machinery dispose of a great portion of their product to electrical machinery manufacturing concerns. One has only to examine an electrical device or a machine to realize what a factor the power press has become

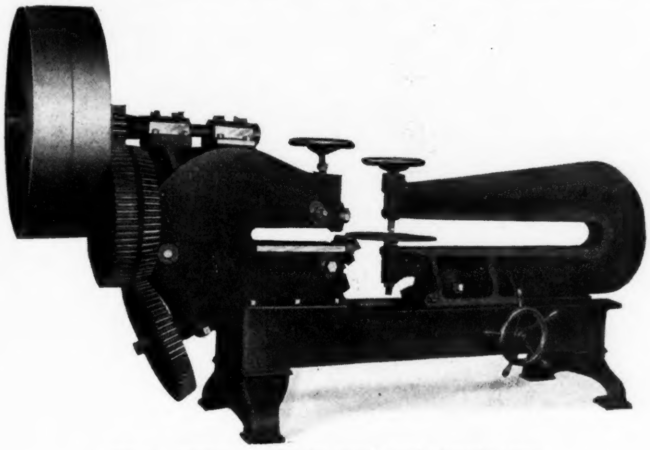


Fig. 1. Circular Shear for Inside and Outside Cuts.

in their production. The parts of electrical apparatus for the production of which such machinery is used most extensively, are armature disks and segments for motors. It is at once obvious that the requirements for such work have led to the designing of dies, presses and special machinery, which differ in essential details from those used in the general and more familiar classes of sheet-metal working.

An armature consists of a wired "core" composed of thin sheet-iron plates or disks averaging from .010 to .040 thick and from 10 to 100 inches in diameter. In many of the best armatures the disks are produced by punching the center hole,

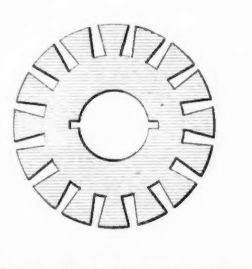
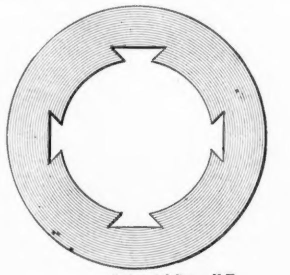
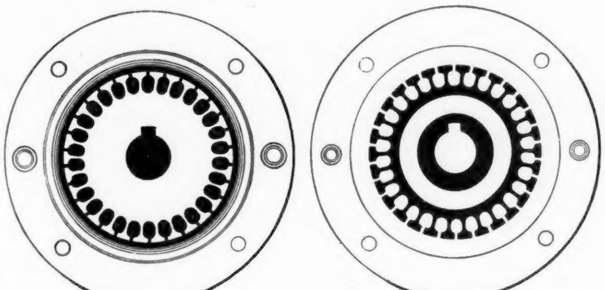


Fig. 4. Disk Produced at One Stroke in a Compound Die.



Industrial Press, N. Y.

Fig. 6. Disk Blank before Notching.



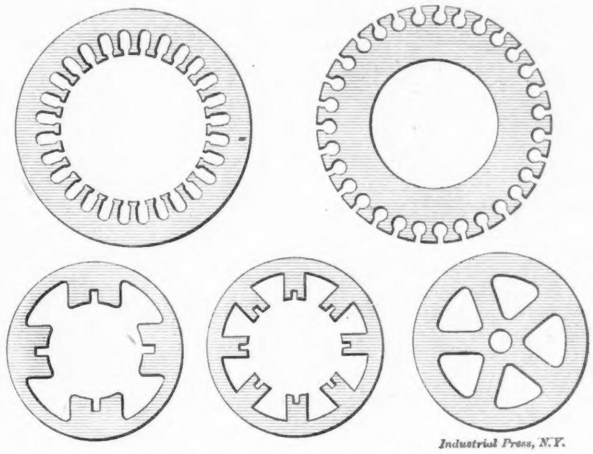
Industrial Press, N. Y.

Fig. 5. Plan of Compound Die and Punch.

keyslots and notches, or winding slots, simultaneously at one stroke of the press. The small sizes are thus produced in dies, while the larger ones are produced in sections or segments of as large size as it is possible to procure iron for. In the cheap and inferior armatures the disks are first punched from plain sheets; the punching of the center holes and the key-slots is a second operation, after which the disks are assembled on shafts, the outside turned to the required diameter and the slots milled on a universal milling machine.

Machines and dies used for cutting and perforating armature disks and segments differ according to the size and shape and number or quantity required. There are in general use four methods for cutting armature disks. On the size and quantity of disks desired depends the practical value of each.

Disks of very large diameters or those required in relatively small lots, are usually first cut plain by shearing the outside circle and afterward the inner circles on circular shearing



Industrial Press, N.Y.

Fig. 3. A Group of Armature Disks.

machines of the type shown in Fig. 1. As shown, the lower cutter is in an angular position relatively to the upper, so as to permit the making of as clean a cut on the inside as on the outside. Disks cut in this manner are afterward notched on an automatic notching machine of the type shown in Fig. 2. A plain blanking or notching punch and die are located in the press portion at the left and a circular disk clamped between the two pads of the indexing and revolving mechanism at the right. The indexing is entirely automatic, the spacing and number of notches in a disk depending on the arrangement of the gearing.

In this machine the adjustment for different diameters is made by simply turning the handwheel shown. The adjustment for different numbers of notches is effected by means

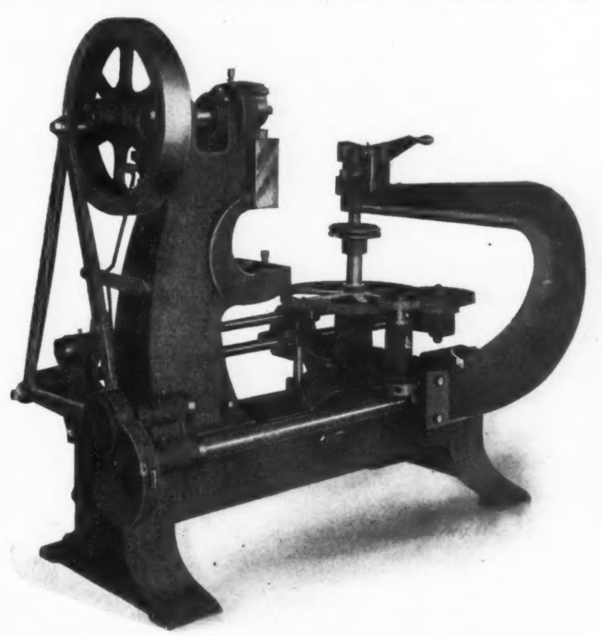


Fig. 2. Automatic Armature Disk Notching Machine.

of the change gears shown, instead of a pawl and index plate device as is usually employed. Each set of gears can be arranged to answer for three different numbers of notches. The index feed is effected by means of a "Geneve" stop movement, but absolute correct indexing is assured by the use of a positive cam-actuated locking device for the indexing arbor.

In connection with the punch and die used in a machine of this type a spring stripper is used, so as to leave a clear space above the die, making it easier to introduce a new disk, and at the same time provide for holding the disk under pres-

sure when the notch is being punched. This, consequently, obviates the necessity of using a clamping plate over the center of the disk.

When disks of the polyphase motor type, having holes or notches punched in the inner periphery are required to be notched in a machine of this type, it is necessary to do the notching before the large inner circle is removed, as its surface is needed for carrying the disks in notching. In such disks one or two small holes are previously punched in that portion of them that is afterward cut away, in order to serve

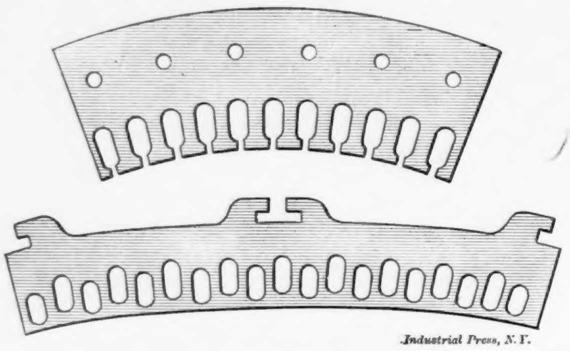


Fig. 7. Armature Segments.

as guides in the notching and center-hole punching operations.

The kinds of disks which are of moderate diameters and most frequently required in large quantities are those used for street car motors. To produce them powerful power presses are used. These presses are equipped with dies so constructed and arranged that the inside of the disk with its key-slot, and the outside with its notches are cut simultaneously at one stroke, as shown in Fig. 4. This method constitutes the quickest, most accurate and economical way of manufacturing armature disks in large quantities. The presses

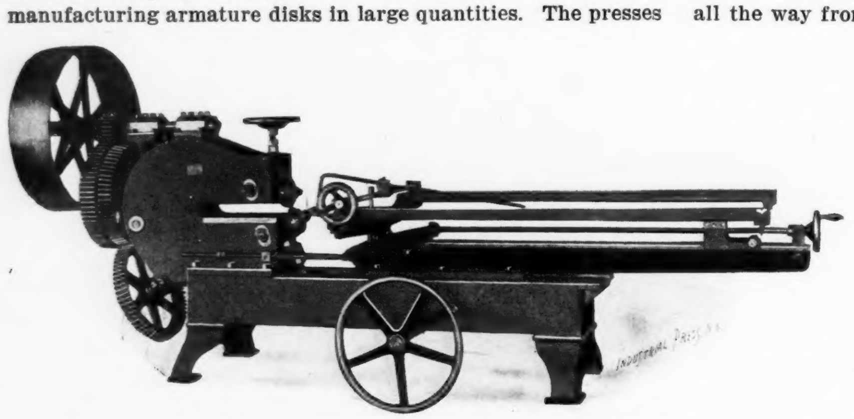


Fig. 9. Circular Shear with Segment-cutting Attachment.

in which such dies as are necessary for such work are used, are provided with knockout attachments which discharge the scrap and the disks so that they lay loosely on top of the dies, thus allowing of their easy removal.

In regard to the power presses used for disk punching, it may be stated that the requirements of armatures for electric work have led to the construction of presses which differ in points from those used for other styles of sheet-metal working. As it is always essential to have the outside and inside exactly concentric, so that all notches in the disks shall coincide perfectly with one another when assembled in "cores," it has been found best to adopt dies, which, by being cut simultaneously, eliminate the inaccuracies which are well-nigh unavoidable when the cutting is done in two or more operations. In many cases, the notches and key-seats are also punched at the same time. To accomplish these results in one operation dies of great accuracy are required, which, in addition to the cutting parts, must be equipped with "knockout" pads that will automatically deliver the punched

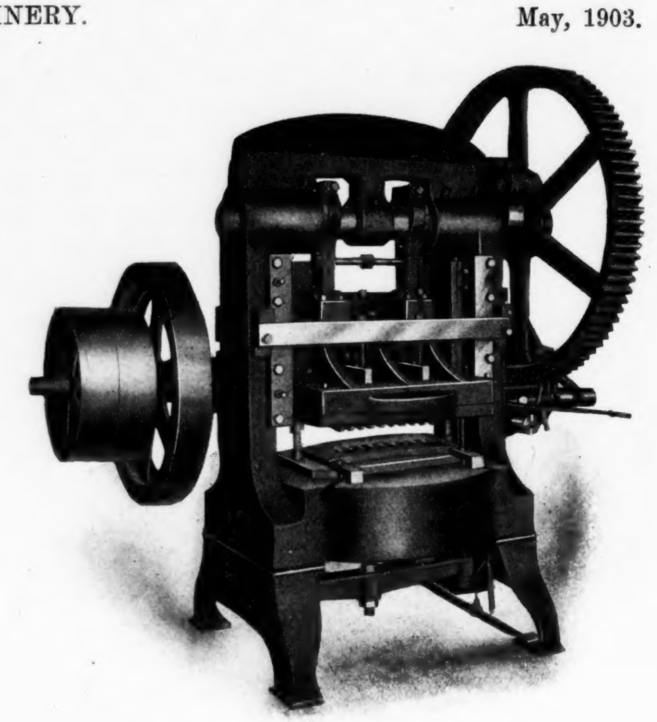


Fig. 8. Automatic Disk-notching Press, Equipped with Positive Knock-out Devices for Punch and Die, and Automatic Friction Clutch.

disks and scrap from within the dies. The dies used in these methods of producing the disks are known as "compound dies," and are usually built up in sections which have been hardened, ground, and lapped to size. However, not infrequently they are made in the usual manner, but the results are not so accurate. These compound dies are very expensive, costing all the way from $150 to $1,000 each. Fig. 5 shows plans of a compound punch and die. As a rule these compound dies are used in presses provided with upper and lower die knockouts, thus obviating the necessity of the strippers in the dies. The die sections are located in a steel casting. The rings are of tool steel, carefully and accurately worked out, hardened and ground to size, while the remaining ones are left soft. The dark sections in the figure indicate the cutting parts.

As the installation of the above described method entails a great deal of expense, and can only be adopted economically where disks are required in large, steady quantities, it is at once apparent that the dies would be too costly to use for producing disks in small lots. For this reason another method is in vogue. This method consists of cutting out simultaneously the plain outside and the hole, as shown in Fig. 6, and then punching the notches on a notching press. By this method a perfectly concentric blank is produced ready to be notched. As by this method the outside notches are cut separately, the power of the presses in which the work is done is equal to much larger diameters than those used in the method before described.

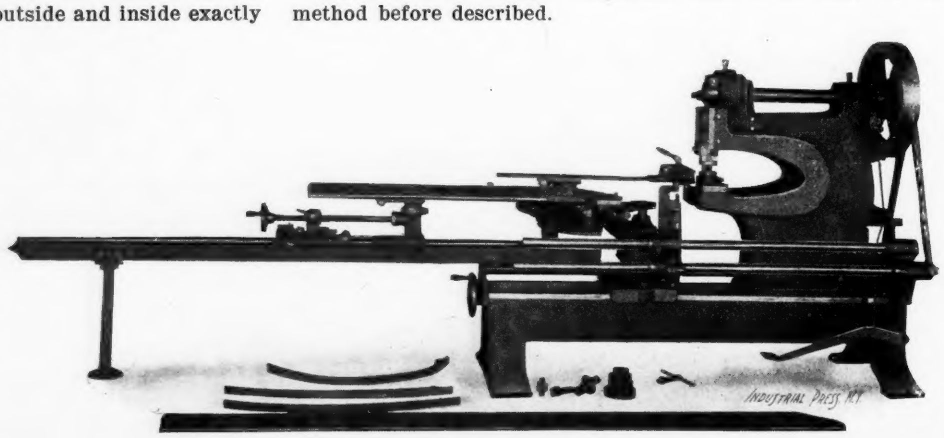


Fig. 10. Armature Segment Notching Press.

In producing very large disks there is a great deal of scrap, but this scrap is prevented from going to waste altogether by being worked over into disks of smaller size. From the inside scrap, the projections corresponding to the key notches are removed by forcing the disk through a circular trimming die, which punches the center hole at the same time, and thus, no great waste of stock is entailed.

In manufacturing armature segments in very large quantities the outside and the holes are usually cut simultaneously in dies in which the stripping of the scrap and the segments from them is entirely automatic, for both the upper and lower sections. A press specially designed and used for this class of work is shown, equipped with proper tools, in Fig. 8. The cutting of sections and segments complete with dovetails, and all notches and holes up to thirty-five, ¾-inch long, can be done on a press of this sort. However, most segments of large size are first punched plain and the notching and perforating are done in succeeding operations.

When the plain segment blanks are not produced in dies, a circular shear of the same type as that used for disk cutting is used, it being equipped with a segment-cutting attachment, as shown in Fig. 9.

In Fig. 10 we have a side view of an armature segment notching press. The segment notching attachment on this machine allows of handling segments having a radius of from 36 to 96 inches and up to 36 inches in length. The manner in which the segments are notched is as follows: The segment to be notched is clamped in a holder at the forward end of a long radius bar, and is traversed across the die face by means of an indexing mechanism and change gears similar to those on the regular disk notching machine shown in Fig. 2. When the segment has been notched all around its outside or inner edge as required, the press stops automatically. After the operator releases a hand lever the segment may be returned to its original position and removed from the press.

* * *

PISTONS AND PACKING RINGS.—4.

UNION IRON WORKS AND ST. JOHN'S PISTONS—A DESIGN BY THE AUTHOR.

J. H. DUNBAR.

With this article, I have the pleasure of showing the readers of MACHINERY a piston and rings as made by the Union Iron Works, of San Francisco, Cal. Mr. W. G. Dodd, vice-president of that company, kindly sent me a blueprint of the piston, and he says they consider it a very good type, for horizontal engines up to, say, 24 inches diameter. For larger engines, they use set-out springs. I enclose the blueprint as I received it, and ask the editor to mark the figures; "Union Iron Works Piston."

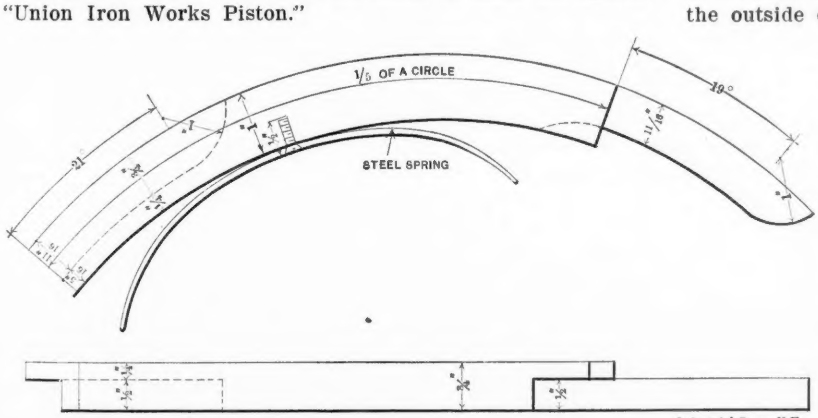


Fig. 2. Piston Ring of Union Iron Works Piston.

It will be remembered that the famous battleship, *Oregon*, was built by the Union Iron Works, and while Mr. Dodd did not say that the pistons in the engines of this celebrated vessel were of the type shown in the print, it is quite probable that they are. There is nothing to prevent them from being practically steam-tight, and nearly frictionless, and it goes without saying that if pistons have these two virtues and can be relied on always to possess them there cannot be much wrong with them.

It sometimes happens that like engines do not give like results, which is usually due to a difference in the conditions under which they have to do their work, rather than to any dissimilarity in the engines. In the case of the *Oregon*, the management, men and machinery were all of an equally high order, and this combination of forces pushed the name of that vessel to an altitude that made it visible to the entire world.

Referring to the Union Iron Works piston, the reader will note the double lap joint of the packing ring, which is a new way, at least to the writer, of cutting them. The body of

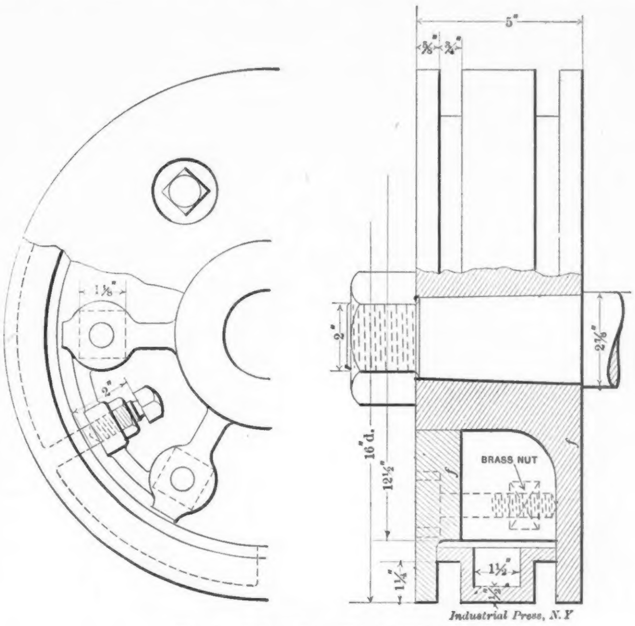


Fig. 1. Union Iron Works Piston.

the ring has a radial dimension of 1 inch and is ¾-inch thick. To form the joint, one end of each section of the ring is milled down till it has a cross-section of ½ x 11-16-inch, leaving a tongue about 20 degrees long. A corresponding slot is milled in the other end of the section. It will be seen that the radial depth of the slot is not uniform, but increases in depth from 11-16 inch at the end of the section, to ¾ inch at the end of the slot. The object in making the joint in this way, is probably to allow the sections to adjust themselves in the cylinder, without cramping the tongues, which cramping would be likely if new rings were to be put in an old cylinder that was worn out of round without some way of compensating for the cylinder's irregularity. It seems to me that a like advantage would be gained in milling off the outside of the tongue, beginning at the heel of it with nothing, and take off say 1-16 at the point, which would very materially increase the diametrical flexibility of the ring at its joints. Machinists, who have had fun trying to loosen follower bolts, and who finally, after twisting them off, have had to drill out what was left in the spider, will appreciate the brass nuts for the follower bolts. As no dowel pin is shown in the blueprint, we may presume that the rings can go around in their grooves as they please. Where the type of ring (as it does in this case) and the roundness of the cylinder permit it, I have found it to be beneficial to both ring and cylinder to let them change relative positions. It prevents any tendency for them to "tongue and groove" each other. If the ring requires to be doweled, it should be allowed, say ½ inch cylindrical play in the groove, to change its situation.

In looking through my notes, sketches, catalogues, etc., I find a circular of the St. John Cylinder Packing Co., and I want to say that I do not think that any company making cylinder packing rings, ever had their rings so highly recommended by so many prominent firms and individuals. To represent the high standing of the firms, I will say that it is claimed that Brown & Sharpe, after trying the St. John packing in one of their engines, put it in all the engines they had. To

illustrate what this packing does, I quote a part of a letter from the general superintendent of the Staten Island Rapid Transit Railroad Company: "The result is a saving of about 10 per cent. in fuel, 75 per cent. in cylinder oil and a great improvement in the cylinders, which are now worn very nearly true, although they were in very bad shape before the change in packing was made." While it would take a whole page or more of MACHINERY to print names and addresses of parties using this packing, and at least a page for letters of recommendation, it is but fair to say that not an engine builder, or steam railroad company's name is on their list. There are, however, plenty of names of builders of steam boats, tugs, battleships, etc.

I remember being favored by a call from a representative of this company, about ten years ago; if I am not much mistaken, it was Mr. St. John himself. He represented with fluency and ease, that his pistons were absolutely steam-tight, frictionless, required no attention, and but a minimum quantity of oil, and would true up a distorted cylinder in good shape in a short time. Then he showed me the long list of his customers, and read letters from some of them. He kept on talking of the phenomenal success of his rings, and at the same time sharpened his Faber, and produced his order book, and asked me to give him the dimensions of the piston for the worst cylinder that I could pick out. Before giving the sizes asked for, I begged the privilege of inquiring into some of the cylinder-truing features of his rings, a favor which he readily granted.

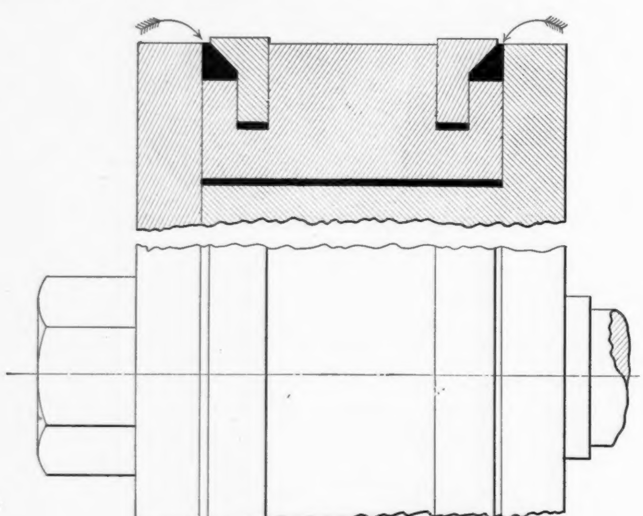


Fig. 3. St. John Piston and Piston Rings.

"Is it necessary to make any change in the steam distribution of the engine, while the rings are truing up the cylinder?"

"No. It does not make any difference to the rings, how you use the steam in the cylinder. It's the rings that true the cylinder, not the steam."

"What do you make your rings of?"

"The best cast iron that we can buy."

"If the iron in our cylinder should happen to be somewhat harder than that in your rings, would that fact make any difference in the cutting action of the latter?"

"No." (Order book disappears.)

"Some of our larger cylinders are perhaps ⅛-inch smaller in the middle than at the ends. As your rings shave this surface metal off, is there not danger of its lodging somewhere, in its passage from the cylinder, and giving us subsequent trouble, as it might do if it was caught between the slide valve and its seat?"

"I have never heard of a case where anything of this kind happened." (Pencil disappears.)

"When your packing has un-humped a cylinder, how do you prevent it from continuing to make a general enlargement of it?"

"That question is very irrelevant, and I must refrain from further trespassing on your time." Then he disappeared, with a smile and a "Glad-to-have-met-you" good-bye, just as if nothing had happened. The next day, which was Sunday, I had the pleasure of listening to him preach an excellent sermon at Trinity M. E. church in this (Youngstown, O.) city. I simply state the facts in this most unusual occurrence, and leave the reader to do what he pleases with them.

St. John's pistons are of the bull-ring type, but I see no reason to prevent his using a single-piece piston if he wanted to, as his only visible feature not common to pistons in general, is the beveling of the outer edges of his packing rings. Fig. 3 is a copy of the cut in his circular—shading, arrows and all. The arrows, of course, show how the steam gets under the lip on the rings and sets them out to the cylinder. It is scarcely necessary to say that the object now is to keep the steam out from under the ring, and let its inherent elasticity do the setting out. There does not seem to be any reason why this piston will not perform all the functions that pistons are expected to, but to imagine that his packing rings will do the boring mill act, is to expect the impossible. There is nothing in the shape of this ring that will true out a distorted cylinder; in fact its shape has no advantage in any respect that I can see over a ring having a prismatic cross-section.

In the upper section of Fig. 3 A is shown St. John's rings reversed in their grooves. Instead of beveling their edges, I leave them square so they can butt up together in the center of the piston. This disposition of the rings would allow the head to be shortened up, as indicated by the vertical dotted lines. This style of packing would also prevent any

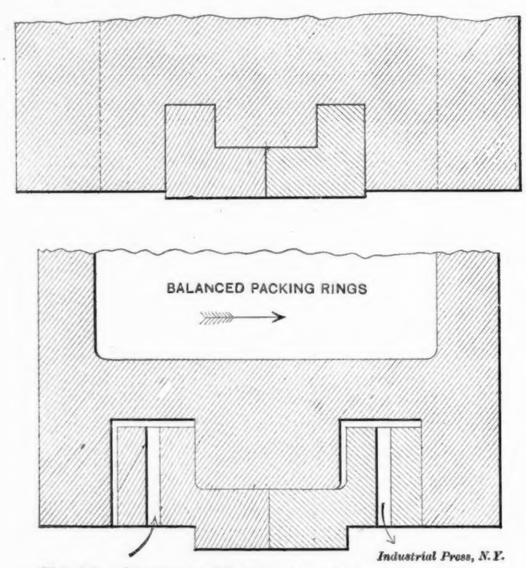


Fig. 3A. Suggested Modification of St. John Piston.

cylinder wear on the piston, and would, I believe, reduce its steam load to a minimum. Then there can be no step wear on the cylinder, as shown in Fig. 8, of December, 1902, MACHINERY. It will also be noticed that the two rings are equal in breadth to the space between the rings in the upper section, so that the piston is supported by like areas in both cases.

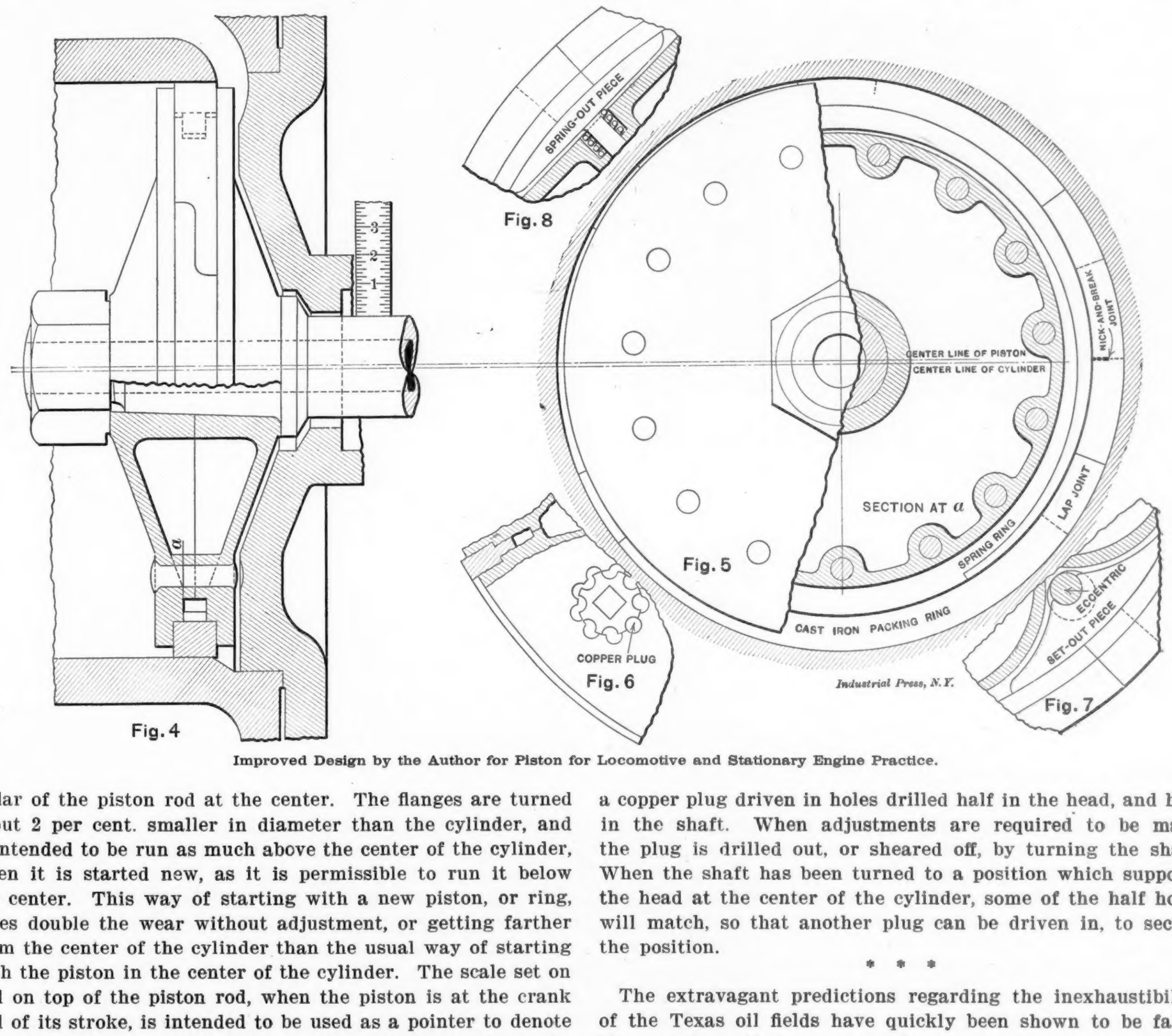
I do not see why we may not follow this same line of reasoning further, and relieve the rings themselves of any but a minimum steam load, by making a negative bevel (calling St. John's positive), on the outside of the rings. As a bevel is objectionable owing to the ring's breadth varying as it wears down, it will be best to scoop out the whole corner, as far back as it would have been beveled, and then we have the same ring area from start to finish. The lower part of Fig. 3 A shows the outside corner of the rings cut away as stated, and it is easily seen that the ring is perfectly steam-balanced in a radial direction; and it is desirable to have it unbalanced in a longitudinal direction, in order that the ring can move sufficiently to make a tight joint with the edges of its groove. But suppose that some steam does leak past, or around the ring, it has an easy way to escape via the radial holes in the right hand ring, as shown by the arrow. Thus it is seen that there is no possible chance for steam to act in an unbalanced radial direction on the rings, with an appreciable pressure. Here we come abruptly to the end of the string which we have been following, so far as theory

is concerned. As to matter of detail we may say that the rings should be loosely doweled, with their joints inside of the arc of contact with the piston, so that no leakage will occur there. An annular tongue on the piston, and a single flanged ring, with a lap cut, kept at the bottom of the cylinder, and the piston would be reduced to its lowest terms, as regards simplicity. Of course, if the ring travels over the counterbore at the ends of the cylinder, it must have lipped edges to keep it from collapsing, at the ends of the stroke.

Before closing the discussion of rings and pistons combined, I ask to be allowed to revise the piston shown in Figs. 6 and 7, of my article in Dec. MACHINERY. I have worked the design over carefully, with a view of adapting it to locomotives, as well as horizontal stationary engines. It is shown in Figs. 4, 5, 6, 7 and 8.

The piston is made of two steel castings, riveted together near its circumference, and clamped between the nut and wears; but the others may be nick and break joints, which consists only in sawing part way through from the inside of the ring and breaking the rest.

For pistons of large diameter, the ring is made having a cross section to fit both grooves, and the sections set out to the cylinder, the same as the Corliss packing, which I now show in Fig. 8, the spring-out piece being placed under each joint in the sections. Where it is desirable to keep the piston close to the center of the cylinder, I show a simple method in Figs. 6 and 7 of setting the ring out at the bottom of the cylinder, and consequently raising the piston. The piston head is milled out, as at Fig. 7, which is a section at a, Fig. 4, to receive a set-out piece which fits over the small part or middle journal of an eccentric shaft, thus keeping the shaft from working endwise, the shaft being journaled in each side of the piston. Fig. 6 is an end view of the shaft, at the face of the piston, and shows that it is kept from turning by



Improved Design by the Author for Piston for Locomotive and Stationary Engine Practice.

collar of the piston rod at the center. The flanges are turned about 2 per cent. smaller in diameter than the cylinder, and is intended to be run as much above the center of the cylinder, when it is started new, as it is permissible to run it below the center. This way of starting with a new piston, or ring, gives double the wear without adjustment, or getting farther from the center of the cylinder than the usual way of starting with the piston in the center of the cylinder. The scale set on end on top of the piston rod, when the piston is at the crank end of its stroke, is intended to be used as a pointer to denote the whereabouts of the piston in the cylinder, without the trouble of taking off the cover. For the smaller sizes of pistons, say 20 inches and under, the packing rings are very similar to those described in December MACHINERY, except the "uplift," making the outside ring in sections, so as to give it ample groove contact, when the piston's flanges are cut down. The narrow, eccentric inside spring ring is to set the outside ring out to the cylinder, and also to prevent an objectionably large area for the steam to act on, on the inside of the outside ring. Both rings are to be doweled in the positions shown in Fig. 5. The points of the inside ring will have to be cut off, to allow it to be snapped into its groove without breaking; but as the piston rests on the outside ring for one-third of its inner circumference, there is no need for the inside ring to be but little over two-thirds of a circle. It will be necessary to make a lap joint in the outside ring at the top, to prevent leakage there as the ring a copper plug driven in holes drilled half in the head, and half in the shaft. When adjustments are required to be made the plug is drilled out, or sheared off, by turning the shaft. When the shaft has been turned to a position which supports the head at the center of the cylinder, some of the half holes will match, so that another plug can be driven in, to secure the position.

* * *

The extravagant predictions regarding the inexhaustibility of the Texas oil fields have quickly been shown to be false. Many of the wells have ceased flowing and have to be pumped. The production has fallen away so that many concerns in the South that were equipped at much expense for burning fuel oil have torn out their oil burners and have gone back to the use of coal. At one time oil sold in the Texas field as low as 14 cents a barrel delivered at tidewater, and even cheaper; now it is 90 cents a barrel and the price is still going upward. The Standard Oil Co. are discouraging the use of fuel oil in manufacturing plants in the North and are refusing to make new contracts for supplying oil to manufacturing plants for a reasonable price as they insist that the supply is becoming so limited as compared to the demand that it is much more profitable for them to refine it. This is most unfortunate, as there are certain kinds of apparatus that cannot be successfully used with any other fuel except a rich gas, and to make the gas it is necessary to use petroleum. The general use of oil fuel for locomotives and steamships seems remote.

THE MAGAZINE HABIT.

W. H. SARGENT.

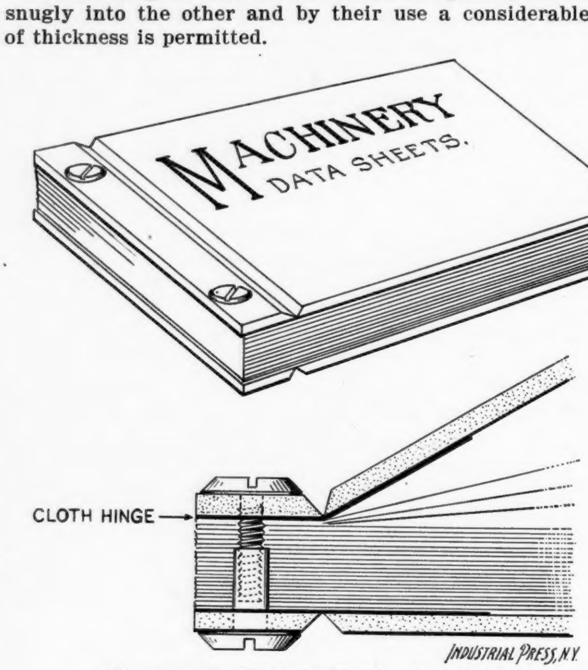
A trade paper is not unlike a group of workmen who get together in the morning before the whistle blows and talk over their experiences in the shop and among their tools. Eventually the group becomes so large and is so widely scattered, that what the Christian Scientists call "absent treatment" must be resorted to, and every man who has an idea or an interesting experience writes it to the editor who sees to spreading it among the other workmen. Sometimes half a dozen of these men will band together and form a magazine club, each one subscribing for a different publication, but all sharing the expense equally. These magazines are then passed from one to the other around the club so that eventually each has the opportunity of examining all and can read or skip as suits his taste. Like books "some are to be tasted, others to be swallowed, some others to be chewed and digested." Too many magazines, even of the best, are of no advantage to a

Fig. 1. Bookcase for Magazines.

club. "The possession of books is not an education any more than the possession of tools is a trade." Occasionally a man will declare that his trade paper is of no use to him; that he could edit a better paper himself. Now the editor is not "A small unbound edition of Moses and Solomon both," and occasionally an assertion will creep in which is not authorized by facts, or perhaps something will be printed as new which is a well-remembered fact to some of the older readers, but in spite of this a vast amount of really interesting and useful knowledge is being printed by the technical journals.

Next to knowing a thing is knowing where to look for it. Since no one remembers all that he reads, many people keep a card index of the articles likely to interest them. Sometimes these articles are cut out and pasted onto the cards which are then grouped under appropriate headings. Others, rather than mutilate the magazine, make a note on the cards, of the volume, number and page, and file the magazine away for reference. In this case the periodicals must either be bound or kept in such manner as will insure their being found when wanted. Most of the mechanical journals are of large size and do not file away conveniently in a bookcase since they project out into the room more than books of ordinary size. To accommodate books of the size of MACHINERY, the writer has designed a bookcase in which the large books are inserted at the end of the case, flat against the wall, while books of ordinary 12mo and 16mo size go in from the front in the usual way. This bookcase is illustrated in Fig. 1, and may, of course, be two or three shelves in height, if desired. The opening for large books should be at the left-hand end so that the front page of the magazine will be in sight.

The data sheets of MACHINERY should be removed and bound separately since they are intended as a handbook for frequent consultation. A practical method of binding these sheets is shown in Fig. 2. The covers are made of heavy picture mat board, beveled at the joint, with a hinge of strong cloth on the inside, as shown in Fig. 3. Two adjustable studs hold the book together and permit new sheets to be added or old sheets to be re-arranged. These studs are in two pieces, one screwing snugly into the other and by their use a considerable range of thickness is permitted.



Figs. 2 and 3. Binder for Machinery's Data Sheets.

The usual stock advice on what to read and how to read it will be left unwritten. There can be no doubt as to the advantage to a workman of a course of reading along the lines of his daily work even at the expense of some of the sensational literature of the day.

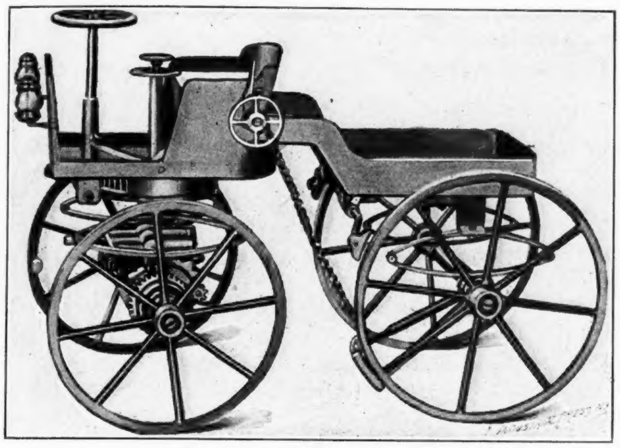
Mr. Dooley says "Carnegie didn't learn to make steel billets reading 'When Knighthood was in Flower.'" The demand today is for practical men who are well posted in their work. "Who reads much soon begins to think." Employers are realizing that well-read men are the most valuable, since a workman's brain can do more work than both his hands. To aid their men in reading good literature, many establishments subscribe to the most desirable periodicals and place these where the men can have access to them. Fig. 4, for instance, shows the reading room of the Casino in the Fairbanks Scale factory, where the daily papers and most of the technical and miscellaneous magazines are always to be found. The appreciation of the men is shown by the well worn condition which the newest magazines soon reach.

Fig. 4. Reading Room, Fairbanks Scale Factory, St. Johnsbury, Vt.

THE SELDEN PATENT.

THE CLAIMS OF THIS PATENT COVER PRACTICALLY EVERY GASOLINE MOTOR VEHICLE.

What will prove to be one of the most famous patent cases in history is that of the Selden patent, which has been the subject of extended litigation and on March 20th, last, was pronounced valid by the United States Circuit Court, Southern district of New York. This patent has broad, base claims covering every kind of an automobile fitted with a liquid hydro-carbon motor, and unless the latest ruling is reversed by the Supreme Court, which is very unlikely, as it is probably not within its jurisdiction, all manufacturers of gasoline motor carriages must pay a royalty to the Electric Vehicle Company, Hartford, Conn., the owners of the Selden patent.



Original Model of Selden Motor Carriage.

The remarkable thing about this patent is that, while it was granted on November 5, 1895, the application was filed in the patent office on May 8, 1879, and was kept alive during that period by the technicality of patent law which allows applications to be renewed year by year, provided an amendment is made when the new application is filed. The patent thus holds on the basis of the conditions existing at the time the application was filed, and is binding for seventeen years from the date of issue in 1895. It was on Thanksgiving of that year that the first automobile races of any account in this country took place in Chicago, under the auspices of the Chicago "Times-Herald" and it is from that time that automobilism may be said to date in America. The patentee, therefore, by his clever manipulation during the formative period of the industry, has managed to reserve his patent rights for a period of seventeen years of active automobile manufacturing, during which time the royalties will amount to millions of dollars; whereas, if he had pushed his claims at the outset, and secured a patent at once, it would have expired at the time when the industry began and would have been valueless.

Selden, the inventor, was a lawyer at Rochester, N. Y., during the seventies and spent his spare time experimenting with horseless carriages. After six years of hard work and the construction of five or six different engines, he produced a carriage that would work, and finally applied for a patent on the same, submitting a model, which is still in the patent office, a cut of which is shown herewith. In his application the inventor made many claims, one of the most important of which is the following:

"I claim—1. The combination with a road locomotive, provided with suitable running gear, including a propelling wheel and steering mechanism, of a liquid hydro-carbon gas engine of the compression type, comprising one or more power cylinders, a suitable liquid-fuel receptacle, a power shaft connected with and arranged to run faster than the propelling wheel, an intermediate clutch or disconnecting device and a suitable carriage body adapted to the conveyance of persons or goods, substantially as described."

The Electric Vehicle Co.'s predecessor, the Columbia and Electric Vehicle Co., secured from Mr. Selden on November 4, 1899, the exclusive rights to his automobile inventions, but only after about six months' negotiation, during which thousands of dollars were expended in investigating the validity of his patents, agents even being sent to Europe to find, if possible, some person who had anticipated the claims of Selden. The improbability of this will be evident when it is remembered that the internal combustion engine did not come before the public to any extent until 1876, at which time Selden was at work on his automobile idea. After this investigation the company immediately commenced a suit against the then strongest outside automobile manufacturer, the Winton Motor Carriage Co., with the object of having the validity of the patent thoroughly proven. The Electric Vehicle Co. was soon assured of a thorough contest, as the principal outside infringing manufacturers organized a defensive association to support the Winton Co. With the news of the entering of the decree sustaining the patent also comes the announcement that all of the most important gasmobile manufacturers in the country have acquired from the Electric Vehicle Co. royalty licenses. Included among these licenses are the Winton Motor Carriage Co., the Haynes-Aperson Co., the Autocar Co., the Olds Motor Works, the Packard Motorcar Co., the Knox Automobile Co., the Peerless Motor Car Co., the J. M. Pierce Mfg. Co., the Searchmont Motor Co., Aperson Bros. Automobile Co., the Locomobile Co. of America, the International Motor Car Co., the Waltham Mfg. Co., the Pope-Robinson Co., Pan-American Motor Co., the H. H. Franklin Mfg. Co., and the United States Long Distance Automobile Co. These companies are representative of the western as well as the eastern industry and comprise all of the best established gasoline automobile makers in the country.

The defendants in the case assert that the Selden claims will eventually be broken, but in view of the action of these several companies it seems hardly probable that such will be the case. As long ago as 1896 the Commissioner of Patents, in his annual report published in the Official Gazette for May 12th, indorses the Selden patent as follows:

"Selden, in 1895, received a patent, November 5th, No. 549,160, which may be considered the pioneer invention in the application of the compression gas engine to road or horseless carriage use."

Such in brief are the main facts about this remarkable patent case which is to affect the whole automobile industry. It is now expected that all the reputable builders of gasoline automobiles will join the Association of Licensed Automobile Manufacturers, with a view to protecting themselves by compelling all outside competing firms to pay the Selden royalties as well as the members of the association. The expenses of such legal action as may be necessary to effect this will be borne by the association as a whole. Many valuable patents will be controlled by the association also. The articles of incorporation are said not to include anything pertaining to the regulation of prices, the object being simply to protect the various patents held by the members.

* * *

BRAZING CAST IRON BY THE PICH PROCESS.

At the regular monthly meeting of the A. S. M. E. in New York, April 7, the topic for discussion was furnished in a short paper by Wilfred Lewis on brazing cast iron by the Pich ferrofix process, which was read by the secretary, Prof. Hutton, as Mr. Lewis was unable to attend. Demonstrations of the process were given in which broken bars of cast iron were brazed, a portable Bunsen burner apparatus and firebrick muffle being used for the purpose. After the reading of the paper Mr. Alexander, of the American Brazing Co., gave an informal talk on the subject, in which he answered questions asked by the members.

He stated that the brazing process actually increases the strength of cast iron bars, if it is properly done, the increase of strength being from five to ten per cent. This refers to the metal adjacent to the joint; the joint itself is always stronger than any other part. The reason for the increase of strength is ascribed to the effect of the ferrofix on the structure of the cast iron by which the free carbon is burnt out by uniting with the ferrofix compound, which is a metallic (copper) oxide. It is owing to this action that it is possible to braze cast iron; the presence of carbon being the reason why cast iron cannot be brazed in the ordinary manner the same as wrought iron and brass. In fact, after the ferrofix paste has been applied and

the carbon burnt out, the actual brazing process does not differ materially from ordinary brazing, spelter and a flux (borfix) being used. The action of the ferrofix is said to be quite penetrating, traces of its work having been detected two or three inches into the solid metal away from the joint, and even further. It is possible to "ferrofix" a small piece throughout.

Mr. Alexander also referred to a comparatively new development of the process that promises to be of great value to iron founders, and that is the repair of castings containing blowholes or other defects, by "ferrofixing" the walls of castings in the holes and pouring molten cast iron into them, which has also been "ferrofixed." His company have repaired several large defective castings at the Cramp shipyard in Philadelphia so perfectly that they passed Government inspection. The size of the holes so repaired did not exceed four or five inches across the largest diameter; what the possibilities are for larger defects is not yet known. To overcome the effect of shrinkage the piece to be repaired is heated as hot as possible and the molten metal is poured at a low heat. The "ferrofixing" of the holes is done by Bunsen burners, great care being taken to get the metal perfectly clean and free of scale, rust, etc. To "ferrofix" the molten metal a small amount, such as can be picked up between the thumb and fingers, suffices for a ten-pound ladle.

In the paper read reference was made to a practice now followed to some extent in Germany in relation to making large castings of complicated shape. Instead of casting such a piece whole they are made in four or five or more pieces and then brazed together, thus avoiding the danger of failure always attending the production of a large piece in one casting. To show the size of work that has been successfully handled a photograph of a large shear was shown which had been cracked vertically through the frame just back of the gap. This crack, which was nearly seven feet long, was repaired without moving the shear from its foundation.

* * *

POWER TRANSMISSION SYSTEM.

The W. F. and John Barnes Company, manufacturers of drilling machinery, have in use at their works a rope transmission system which is distinctly novel. One objection to rope transmission as ordinarily installed, is the splice joining the two ends of the rope. It usually requires the services of an experienced person to make it, considerable time is required for splicing, and unless the work is well done the splice will be larger than the body of the rope, causing undue wear and unsatisfactory running. The fact that the rope must be spliced

Fig. 1. Metallic Fastener for Ends of Rope.

has also made necessary the use of twisted rope of cotton or hemp, instead of braided rope, which is said to be considerably stronger and more durable, although we have not been able to find a record of tests to substantiate this.

In the Barnes system, braided rope is used, and the ends are joined by a metallic belt fastener, the invention of Mr. B. F. Barnes, who has patented the device. The fastener consists of a metallic ferrule, shown in Fig. 1 and in section in Fig. 2, with the two ends of the rope to be joined. The ferrule is of

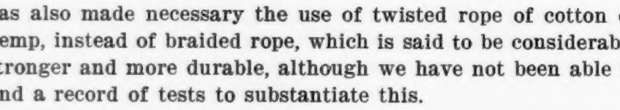


Fig. 2. Section through Fastener and Rope.

such a diameter that it will slip over the ends of the rope. In applying it, one end of the rope is inserted to about the center of the ferrule and fastened securely in place by forming an annular groove at one end of the ferrule, deep enough to indent both the ferrule and rope. This groove is made by a special hand tool, shaped like a pair of pliers, with one wide and one narrow jaw, both of which are curved as in a pair of gas pipe pliers. One of the jaws is narrow for grooving and the other is broad to back up and support the ferrule in the process. The next step is to drop a small quantity of melted wax into the open end of the ferrule and upon the end of the rope, and while the wax is still warm, the other end of the rope is inserted in the open end of the ferrule and forced against the wax. By twisting the rope somewhat and pressing it into the wax the latter becomes imbedded in the fibers and as it cools, forms a hard, solid lump. If necessary, the ferrule may be heated to keep the wax soft while this is done, and before the wax hardens, the other end of the ferrule is creased and the joint is complete.

The surprising thing about the system in use by the Barnes company is the small diameter of the rope. The American or single-rope system of transmission is used in which a single rope passes back and forth between the grooves of the driving and driven sheaves, making as many lengths of rope as are

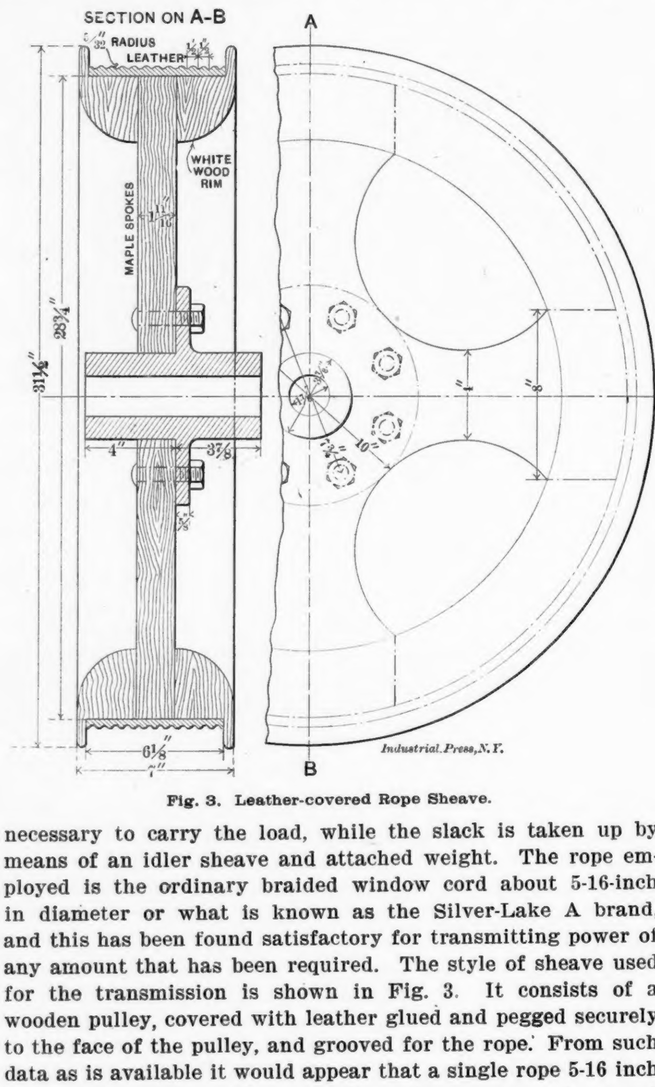


Fig. 3. Leather-covered Rope Sheave.

necessary to carry the load, while the slack is taken up by means of an idler sheave and attached weight. The rope employed is the ordinary braided window cord about 5-16-inch in diameter or what is known as the Silver-Lake A brand, and this has been found satisfactory for transmitting power of any amount that has been required. The style of sheave used for the transmission is shown in Fig. 3. It consists of a wooden pulley, covered with leather glued and pegged securely to the face of the pulley, and grooved for the rope. From such data as is available it would appear that a single rope 5-16 inch in diameter would easily transmit one horse power at a speed of 1,000 feet per minute; or in other words would transmit as much power as a single leather belt one inch wide. One 16-rope drive is transmitting regularly 57 horse power at a speed of 3,225 feet per minute; another drive with 10 ropes is transmitting 27 horse power at a speed of 3,900 feet per minute. A severe test of the system is to be found in the application of the drive to the woodworking shop where a surfacing planer, saws, lathes, etc., are in operation. The writer saw the planer belt shifted on and off repeatedly and it could not be noticed that this affected the rope drive for this department to the slightest degree.

* * *

The compound gas engine in which a cylinder of larger dimensions receives the exhaust from two smaller cylinders, seems to be a practical success. Engines of this type are being made by Crossley Bros., Manchester, England, and we have recently seen an experimental engine of the same type in New York that is pronounced a success, being reliable in action and considerably more economical in consumption of gas than the simple type.

AN OUTLINE OF THE MANUFACTURE OF NITROGLYCERINE.

While killing time waiting for a train at Olean, N. Y., a few weeks ago the writer dropped into a machine shop near the Pennsylvania Railroad depot in which are manufactured supplies for the oil well business, including among other things, machinery for the manufacture of nitroglycerine. Mr. Luther, the proprietor, besides being a practical mechanic, has had experience in the manufacture of nitroglycerine, and he gave the writer a somewhat thrilling account of it. He insisted, however, that the danger was not greater than in many other hazardous occupations—provided the maker is not a careless man and that he never makes mistakes. If he *is* careless—well, the coroner will have a hard time to find the remains, and will have no difficulty in finding the cause.

The manufacture of nitroglycerine is a simple operation; in fact nitroglycerine is one of the simplest explosives to manufacture known. Mr. Luther said that it was small cause for wonder that anarchists and other evil-disposed persons use nitroglycerine for their destructive acts. In the first place, it is, of course, the most destructive for bulk and weight, and then it is so easily made from inexpensive materials. A few pints of nitric and sulphuric acids in about equal proportions, a small quantity of sweet oil of glycerine, a stone jar, a bucket of water and a wooden spoon complete an outfit with which a person of comparatively little skill can in twenty minutes make enough explosive to blow up a five-story block.

The commercial apparatus for manufacturing nitroglycerine consists essentially of a nitrator, a drowning tank, a power wash tank, and a lead-lined storage tank. These are arranged like the steps of a stair, the nitrator being at the top, beneath that the drowning tank filled with cold water, then the power wash tank filled with warm water, ending with the storage tank for the finished product. The nitrator consists of a circular iron drum setting in a square tank fitted with water connections so that a constant current of water can be circulated around the inner tank in which the nitric acid, sulphuric acid and glycerine are combined. The top is covered over, and through the center passes the shaft of a vertical paddle driven by hand or power. An opening in the top is fitted with a pane of window glass so that the interior can be seen. The sulphuric and nitric acids come to the nitroglycerine factories already mixed in iron tanks containing about 1,500 pounds each. With this amount of acid about 220 pounds of glycerine are mixed. During the mixing process the paddle constantly agitates the mass and the operator keeps close watch of a thermometer immersed in the tank while with one hand he regulates the flow of the glycerine into the tank by means of a valve. The chemical reaction causes heat and if the temperature reaches 115 degrees trouble is likely to come "mighty sudden." If there is a tendency for the temperature to go too high the glycerine is shut off, the effort being to keep it down to about 70 degrees, but sometimes the temperature continues to go up even when the glycerine is shut off and possibly the mass will catch fire and burn with a bluish flame. In this case the mass is drawn off into the drowning tank which is filled with cold water and then allowed to cool down.

When the action goes along smoothly the combined mass is drawn off into the drowning tank just the same after the reaction is complete, where it sinks to the bottom and cools. From the drowning tank it is drawn off into the power wash tank filled with warm water. Here the mass is agitated until the uncombined acids are washed out. No metallic surfaces are allowed to work together in the presence of nitroglycerine. Consequently no valves are used in the pipes; instead hose are used, the flow being shut off by hooking the discharge end up above the level of the tank being drawn off. The paddles of the agitators are made of iron, all parts of which are welded together. No riveted or bolted construction is allowable in any metallic working part, for the reason that the points spring open more or less when working and if any nitroglycerine gets "pinched" there is something doing right away.

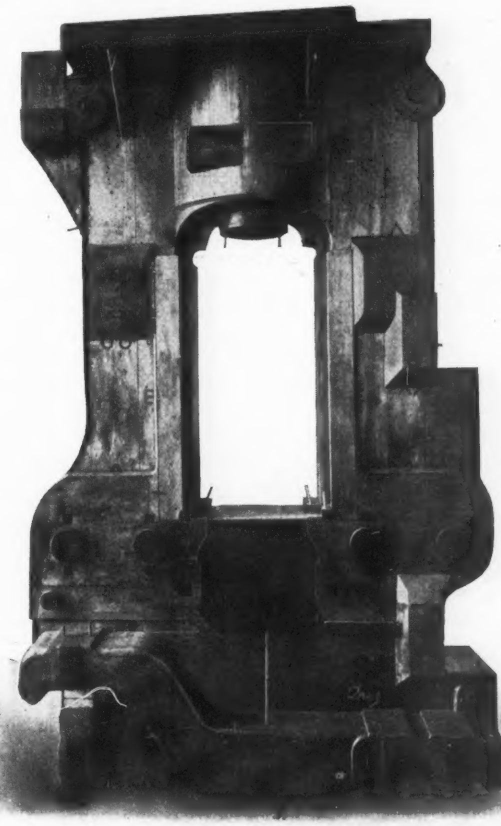
The nitroglycerine business is an exception to the general tendency toward consolidation. The danger of the business prohibits manufacture in large quantities at a time in one factory and the rigid rules of the railroads against transporting it make it necessary to manufacture it somewhere near the place it is to be used. Some secluded spot is chosen, usually on the side of a hill where a cave can be dug for storing it.

Dynamite is nitroglycerine mixed with some substance that absorbs it and reduces the danger of accidental explosion. Soda and wood fiber are largely used for this purpose.

* * *

PATTERN FOR SIXTY-FIVE TON HOUSING.

A somewhat interesting example of the heavy pattern work called for in the building of modern rolling mill machinery is that shown in the illustration. It is a pattern recently made at the works of Mackintosh, Hemphill & Co., Pittsburg, Pa., for the cast iron housings of a 32-inch slabbing mill which they are building for the Lackawanna Steel Co.'s new plant at Buffalo, N. Y. The mill has four of these massive cast iron



Example of Large Pattern Work by Mackintosh, Hemphill & Co.

housings, each weighing about 65 tons. A comparative idea of the size of the pattern and, of course, of the casting made from it, can be gained from the two-foot rule shown resting against the base.

This slabbing mill, which is said to be the largest yet built in this country, is designed to handle ingots up to 30 inches thick and 54 inches wide. It gives one an idea of the massiveness of the rolling mill machinery now required for the manufacture of the larger commercial steel products.

* * *

The *Western Electrician* illustrates in a recent issue a miniature electric motor which was built by one Joel Ettinger in 1851 at York, Pa., and which is now in the possession of the York Historical Society. This motor, which is among the earliest produced by American inventors, operates on the principle of an armature, being alternately attracted to the poles of an electro-magnet and then released. The oscillating motion thus produced is converted into rotary motion by means of a small walking-beam and a crank. The source of energy was a galvanic battery. The model is in perfect order and although nothing ever came of it directly, it is of considerable interest now, in view of the great development of electrical machinery.

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MACHINERY

DESIGN—CONSTRUCTION—OPERATION.

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MAY, 1903.

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MACHINERY is issued in three editions—the Engineering Edition, printed on coated paper throughout, each volume comprising 650 reading pages and forty-eight 6x9 data sheets—price $2.00 a year; the Shop Edition, printed on super-calendered paper, comprising 430 reading pages, devoted to practical shop matter—price $1.00; and the Foreign Edition, which comprises the same matter as the Engineering but is printed on thin paper for transmission abroad—price $3.00 a year.

The privilege conferred on railroads by which they can condemn private property when required for right of way, track extensions, or other purposes necessary to efficient operation, is sometimes a serious menace to manufacturing establishments so located as to be in the way of such extensions. Especially is this the case when a large group of buildings is planned and all arrangements have been made to concentrate a number of plants into one large one. To have a railroad company seize part of the land necessary for such a plant before the buildings had been erected, would undoubtedly entail greater damages to the private concern than any court would award them in condemnation proceedings. To head off an occurrence of this nature a large concern that is now building an extensive plant in New Jersey on ground likely to be wanted by the Pennsylvania Railroad, incorporated an industrial railway which is to be built to serve the various buildings of the plant. The articles of incorporation not only cover the rights to build on the ground level, but also on various other levels, thus effectually shutting off seizure of the property by another railroad. Not a bad scheme by any means—that is for the concern.

* * *

THE INVENTOR UNDER MODERN CONDITIONS.

The nineteenth century has been characterized as the age of invention and the twentieth century bids fair to be known as the age of combination. The query naturally arises as to what effect combination will have on invention—whether the inventive genius of the nineteenth century will continue and increase in the twentieth, or whether combination will stifle invention.

A contribution on the subject that has attracted much attention is an article by Mr. William Stanley upon "The Inventor and the Trust" in the *Springfield (Mass.) Republican.* Mr. Stanley shows how the trust sometimes swings its club over the head of the inventor and deals him a crushing blow. The trusts have patent bureaus with strong legal talent prepared to exhaust the resources of any competitor or individual inventor by extended litigation and legal procedures extending, perhaps, through many years. By this means control of many patents is secured while the honest inventor passes from view, sadder and poorer.

Sometimes, when a patent is issued the trust attorneys decide that their organization should own it and a low price is offered, along with the statement that one of their own inventors had worked out the same result some years before. Unless the inventor sells the patent then and there he may be subjected to coercion. First, notice may be served on him by the United States Patent Office that (although this patent was issued to him) an interference had been declared between his patent and a new application. Testimony is then taken as to dates of invention claimed by both parties. In all probability the real inventor proves priority, and the contending application is dismissed; but—and here the important part comes in —the trust lawyers are now in possession of the inventor's sworn dates of invention, back of which he cannot go. Another application signed by another applicant is put into interference with him. Again the dates of invention are given, and the inventor now realizes that he has a hard fight for his patent on his hands.

While admitting the truth of these statements, it is evident that abuses of the patent system are amenable to law and Mr. Stanley makes several suggestions for the control of patents and the methods of patent litigation that he thinks will work a change for the better. We would like also to remind the reader that the way of the inventor has always been hard and that on the average he has not obtained what was his due. This was the case at the beginning of the last century when many ideas were originated but could not be carried out because tools and facilities for manufacturing were lacking; it was so still later at a time when people of means had not become conversant with the possibilities of mechanical development and looked upon many practical schemes as visionary; and later still, the litigation, now carried on so successfully by large corporations, was conducted by individuals with quite as much disadvantage to the inventor as at present. For our part, we do not believe that the inventor has any harder row to hoe now than in the past.

On the contrary, there are many more channels for invention and more things to be improved than ever. There is the accumulated experience of years to take advantage of; and of more importance still, there never was a time when capital could be so easily raised to promote a good invention, provided the inventor had the business ability to bring his work into prominence. The main trouble with the inventor at all times has been that he has lacked this business ability. He has not been able to meet his opponents on equal ground. An early instance of this was the case of Oliver Evans, the brilliant Philadelphia engineer who failed to score the pronounced success of his contemporaries, Stevens and Fulton, because he was not a man of affairs and was not able to command the resources of the latter two. From that day to this scores of similar instances could be cited and while inventors may be and undoubtedly are now imposed upon by large corporations, these very corporations have made possible the development of certain patents which could not have been developed in any other way. If an inventor has not the ability, backing or influence to take advantage of these conditions now, we doubt very much whether he would have been able to achieve success under the old order of things.

* * *

While it may be quite generally understood that the building of steam boilers in the leading shops is one of the best examples of rapid constructive work of high grade, we think there are many who scarcely appreciate the rapidity with which the standard horizontal tubular is put together where such work is made a specialty. The writer was recently assured by the vice-president of one of the largest boiler making concerns in the United States that they were able to commence a boiler in the morning and have it completed, tested and loaded ready to ship on the evening of the succeeding day, and that they frequently built them complete in less than 48 hours. In connection he mentioned an amusing occurrence which bears out what we say in the opening sentence. A large steel concern in Western Pennsylvania gave his firm a rush order for a battery of horizontal tubular boilers. A force of men were concentrated on the order and a record made, the result being that the boilers were completed before the specified time. They were loaded and shipped, and arrived at the new works before the foundations were ready to

receive them. The concern, thinking that it was impossible for the boilers to have been built to order in so short a time, accused the makers of palming off second-hand boilers on them, and it required considerable explanation to assure them that such was not the case. It may be mentioned that nearly all the product of the boiler concern is insured by the leading boiler insurance company of this country, which is a pretty good guarantee of its trustworthiness, so that rapid work does not by any means indicate poor work in the boiler business.

* * *

STEEL AS AN ABRASIVE.

A hindrance to the more extensive use of toolholders with inserted tools of self-hardening steel has been the troublesome job of cutting the steel bars into suitable lengths for use. It has been necessary either to heat the steel and nick it, or to break it off cold, leaving a ragged edge. The new cutting-off machine for this purpose recently brought out by the Armstrong Bros. Tool Co., which is described in another column, seems to make this operation much more convenient and draws attention to a shop process not commonly known or at least seldom utilized. In this machine the cutting is performed by a tool-steel disk rotating at high speed. The disk has no teeth, but wears itself through the steel bar without difficulty. The disk apparently partakes of the nature of an abrasive wheel, and the theory is advanced that the abrasive substance is made up of minute particles of the steel being cut which become imbedded in the edge of the disk and apparently give to the disk the cutting or wearing-away action that it has upon the bar of steel. This conclusion seems reasonable from the fact that the steel disk does not wear appreciably, indicating that its edge must be continually renewed from some source. It is also noticed that a new disk has very little effect on the bar at the start, but after it has run in contact with the bar for some time, it begins to cut into it more rapidly, apparently because the steel particles have become imbedded in it.

A machine, similar in principle to the Armstrong cutting-off machine, has been in use at the Pennsylvania shops at Sunbury, Pa., for several years, but for an entirely different purpose. This machine has a spindle on one end of which is a disk of tank steel running at a peripheral speed of 9,000 feet a minute, used for cutting off locomotive flues. On the other end is a steel cupped wheel made by flanging an ordinary steel disk. This wheel is used like an emery or any abrasive wheel for squaring off the ends of the flues after cutting, by simply forcing the end of the flue against its surface until the tube becomes square. It takes about 30 seconds to cut off a two-inch flue and the disk itself does not wear perceptibly. One disk is said to have been in use for seven years. The flue becomes red hot at the point where the cutting is in progress and it is a question whether this softening and possibly melting action may not account for the performance of the disk rather than the theory of imbedded particles in the surface. It apparently sets up a condition akin to that encountered by a hot saw in cutting off rails in a steel mill. And if this is the case, who can explain the action of the cupped wheel in squaring the ends of the flues? There is an opportunity here for a new line of investigation and possibly for the development of a new abrasive process of great value in shop operations.

* * *

THE STATUS OF ALCOHOL MOTORS.

Space is given this month to a review of the progress abroad in the use of alcohol for industrial purposes, especially in internal combustion engines. Engineers in Germany, France and Russia have given much attention to the matter and as there are no restrictions corresponding to our internal revenue tax on spirits there is every promise of extensive development of alcohol motors.

Compared with gasoline, alcohol is at a disadvantage from the commercial standpoint, though in respect to efficiency, considered simply as a heat motor, it has the advantage. Strong arguments in favor of alcohol for power purposes are that its production can never be restricted sufficiently to come under the control of a trust and that it is not a dangerous explosive like gasoline. It can be produced easily from a variety of vegetable products, its manufacture from the potato receiving a great deal of attention abroad at the present time. It is customary to denaturalize alcohol that is to be employed for industrial purposes by adding some distasteful element to prevent its use as a beverage by those who are habitually thirsty. It is said that in countries where its manufacture for the arts is encouraged by the removal of the internal tax on this denaturalized product, there has actually been less intoxication. This is ascribed to the disposition of the dealers to sell the commercial alcohol on which there is a good profit, rather than pay a heavy license fee for the privilege of selling the pure alcohol for beverages on which the profit is no greater.

Speaking in a general way, alcohol contains only about two-fifths as many heat units per pound as gasoline and thus at the start is at a disadvantage, without regard to the cost. Tests quoted in our contributed article, however, show the efficiency of an alcohol motor to be from 25 to 30 per cent., while it is known that the efficiency of a gasoline motor ranges from 15 to 20 per cent. In the absence of further details, we are able to account for this only by the fact that a mixture of alcohol vapor and air can be compressed in the engine cylinder previous to ignition to a much higher pressure than can a mixture of gasoline vapor and air without becoming hot enough to produce premature explosion. In the tests referred to, the compression in the alcohol motors was carried to 10 or 15 atmospheres, and it is well known that the efficiency of a gas engine depends largely upon the extent of compression.

The number of gallons of alcohol consumed per horse power hour would be considerably more than the quantity of gasoline that a gasoline engine would require per horse power hour. In the tests quoted in our contribution the consumption of alcohol is about one pound per horse power hour when the engine is loaded economically, which is equivalent to one-sixth or one-seventh of a gallon; while a gasoline engine should run on one-tenth gallon under similar conditions. This, coupled with its higher price, is the main argument against the value of alcohol as an engine fuel at the present state of the art. Experiments show, however, that a carburized alcohol, 50 per cent. alcohol and 50 per cent. of some petroleum product, gives results rather better than gasoline alone, and the mixture can be used in existing gasoline engines without extensive changes.

We are of the opinion that the removal of the tax on alcohol for the arts in this country would lead to important developments in internal combustion engines and that probably for every dollar thus sacrificed the impetus that cheap alcohol would give to chemistry and the industrial arts would net very handsome returns.

* * *

Prof. R. H. Thurston in a paper, "Heat Exchanges Within the Steam Engine," read before the American Association for the Advancement of Science, December, 1902, referred to experiments that prove the steam consumption of an engine is practically unaffected whether compression takes place, or not. The mean of twelve tests made by Prof. Dwelshauvers-Dery on his experimental engine at Liege, Belgium, at 0.47 compression, gave the consumption at 24.526 pounds per horse power; without compression the mean of thirteen subsequent experiments showed the consumption to be 24.532 pounds per horse power. The steam remaining in the cylinder of a simple engine at the end of the exhaust period is dry and sometimes even slightly superheated; the walls of the cylinder are also dry. When compression begins the temperature of the steam rises and continues to rise as compression proceeds until its temperature equals that of the cylinder walls. During this period the pressure increases until the temperature of the steam exceeds that of the cylinder walls when it begins to yield up heat to the latter, producing the curious hook in the indicator diagram which has often been erroneously attributed to leakage. Prof. Thurston concludes that in the light of recent experiments it is not necessary in ordinary construction to assume the presence of water in the cylinder to account for certain phenomena; and that there is no real conflict between theoretical and "experimental" thermodynamics of the steam engine.

ALCOHOL FOR INDUSTRIAL PURPOSES.

THE RESULTS ACCOMPLISHED IN THE USE OF ALCOHOL FOR HEAT, LIGHT AND POWER.

In one of his consular reports, Consul Mason, of Berlin, dwells upon the potato as a source of wealth in Germany, in which he considers the potato, not only as a food, but as the basis of many technical products of value, notably of alcohol for use in the arts. Everywhere there is an indication of a larger use of alcohol for lighting and heating purposes and for power. At the Exposition of 1903 there were exhibits by fifty firms of apparatus for the manufacture and use of alcohol for technical and industrial purposes, each firm displaying from two to twenty machines or pieces of apparatus.

The German government have done a great deal to stimulate the use of alcohol for practical purposes and the Russian government have employed alcohol boat motors of 300 horse power in the navy with highly successful results. Among the exhibits at the exposition was a 50 horse power Russian marine engine, of the internal combustion type, using alcohol, and directly connected to a dynamo. Its efficiency will be inferred from the tests, which showed its alcohol consumption to vary from 0.45 to 0.5 liter (.47 to .53 qts.) per horse power hour. At 650 revolutions per minute it developed about 61 horse power and ran with such steadiness that the difference between running light and with full load was only 3 per cent. Like many other alcohol motors, this is started and warmed up with gasoline, and a lever changes the supply from gasoline to alcohol as soon as full speed has been attained. The ignition is by electric spark, and the moment of ignition can be adjusted to occur at the most advantageous part of the stroke, thus securing maximum economy.

The department devoted to lighting apparatus at the exposition included a varied display of lamps, chandeliers, and street and corridor lights, in which alcohol vapor is burned like gas in a hooded flame covered by a Welsbach mantle. Under such conditions alcohol vapor burns with an incandescent flame which rivals the arc light in brilliance and requires to be shaded to adapt it to the endurance of the human eye.

Similarly attractive and interesting was the large display of alcohol heating stoves, which, for warming corridors, sleeping rooms, and certain other locations, are highly esteemed. They are made of japanned iron plate in decorative forms, with concave copper reflectors, are readily portable, and, when provided with chimney connections for the escape of the gases of combustion, furnish a clean, odorless, and convenient heating apparatus.

Cooking stoves of all sizes, from the complete range, with baking and roasting ovens, broiler, etc., to the simple tea and coffee lamp, were displayed this year in endless variety. This entire department—the use of alcohol for household purposes—is ably and efficiently managed by the Central Association for Alcohol Distribution, which keeps a large depot in Berlin and other German cities, where everything that can use denaturized alcohol is kept on sale. As another example of the efficiency of this organization may be cited its system of alcohol distribution to rural districts. Since the inception of the movement steam has in many instances been displaced by alcohol motors for threshing, grinding, fuel cutting, and other agricultural purposes, it being claimed that the alcohol motors have the advantages of immediate readiness of operation, no coal or water to be provided, no fireman needed, freedom from smells or danger of fire, and, finally, greater economy of maintenance. But in order to promote the substitution of spirit motors for steam and horse power, it was necessary to make alcohol cheap and easy to obtain by farmers in districts where no raw spirit is made. To meet this requirement, the Central Association undertakes to deliver free at any railroad station in Germany denaturized alcohol of 90 per cent. purity, in quantities of 180 to 200 liters, for 15, 16½, and 17½ pfennigs per liter (approximately 15, 16, and 17 cents per gallon), according to the material with which it is denaturized. As the consumption of a modern alcohol motor for farming purposes is about 0.5 liter (costing about 2 cents) per horse power hour, it will be apparent that in this country at least benzine and petroleum have met a serious competitor as fuel for motor purposes. The Hamburg-American Steamship Company has in service a harbor-inspection launch which, with a 23-horse power spirit engine, makes a speed of 10 knots, and preparations are being made to greatly extend the use of such motors in the launches and ships' boats of the German navy.

Internal Combustion Alcohol Motors.*

The use of alcohol as a motor, while having been tried by Brayton in Philadelphia as far back as 1876 or so, received but little impulse until 1894-5, when Germany took it up to encourage its agricultural and distilling industries. In France Lockert in 1896 made experiments, as did Arachequesne, Pétréano and others. The French Department of Agriculture, in direct contrast to that in Germany, discouraged the attempts as Utopian. The Paris newspaper "Vélo" in 1899 inaugurated a contest of alcohol-driven automobiles and bicycles; from Paris to Chantilly. Four automobiles appeared, only one started. The weather was bad. The trip of 137 kilometers (85 miles) was made by an Armand & Briest machine with two persons, in 8 hours 8 minutes; that is, 17 kilometers (or 10.6 miles) per hour. The consumption of pure spirit was 37 liters (= 9.87 gallons).

In 1899 Gutman put on the market a carburetted half-and-half alcohol which was tested in a benzine motor; the results were gratifying. The Exhibition of 1900 showed the Körting pure alcohol motor and the Martha carburetter on a Dietrich carriage. The "Criterion of Alcohol" in 1900 was "a bolt from the blue." There were 40 entries for the Paris and Rouen competition. Of these, four used pure alcohol; one, the new carburetted spirit of Leprêtre.

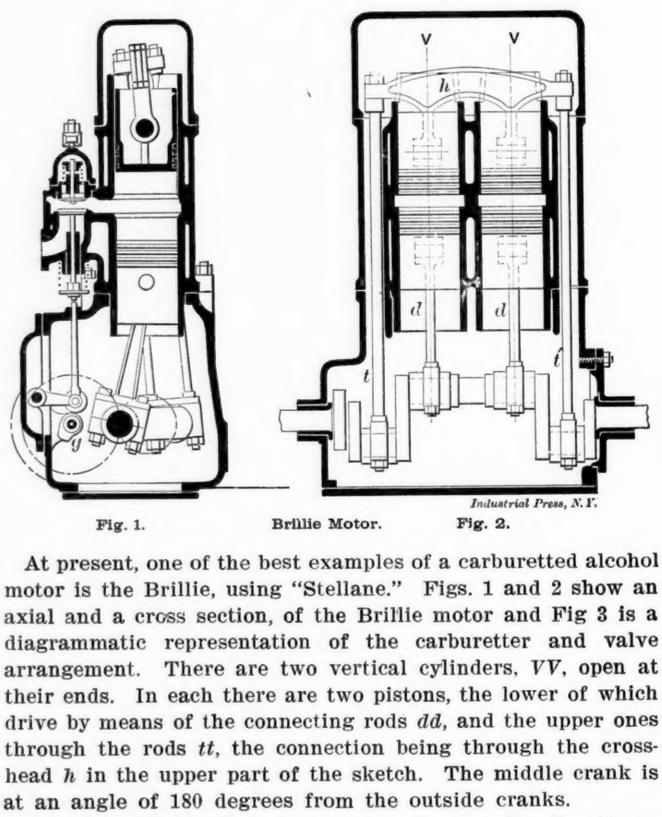


Fig. 1. Brillie Motor. Fig. 2.

At present, one of the best examples of a carburetted alcohol motor is the Brillie, using "Stellane." Figs. 1 and 2 show an axial and a cross section, of the Brillie motor and Fig 3 is a diagrammatic representation of the carburetter and valve arrangement. There are two vertical cylinders, *VV*, open at their ends. In each there are two pistons, the lower of which drive by means of the connecting rods *dd*, and the upper ones through the rods *tt*, the connection being through the crosshead *h* in the upper part of the sketch. The middle crank is at an angle of 180 degrees from the outside cranks.

In each cylinder the pistons move in opposite directions; the explosive being produced between them. The motor is of the "four cycle" type and the cycles in each alternate with those in the other, so as to give one impulse per rotation. In order to get the best possible counterbalance the throw of the middle crank is longer than that of the outside cranks, thus compensating the difference in mass by difference in piston speed.

The distribution is effected by vertical valves, shown in Fig. 3, the upper one of which is the intake, working automatically, and the lower one the exhaust, operated by a cam on the cam shaft *g*. A distributing wheel *G* is employed for introducing the alcohol. It is in the form of a conical plug having pockets around its periphery, and as the distributor revolves these pockets become filled with the liquid from the

* Contributed by Robert Grimshaw.

reservoir and are successfully brought before the orifice at the left where the liquid is forced out by a blast of air in pipe *P* and vaporized in intake pipe *M*.

The rotation of the distributor plug is effected by a ratchet mechanism under the control of the governor. There are as many teeth in the ratchet as there are pockets in the distributor, so that every time the ratchet is advanced one tooth a pocket containing a charge of alcohol is brought opposite the atomizer. The governor which controls the rotation of the distributor is of the inertia type, working on the hit-and-miss principle. A weight is oscillated back and forth by an eccen-

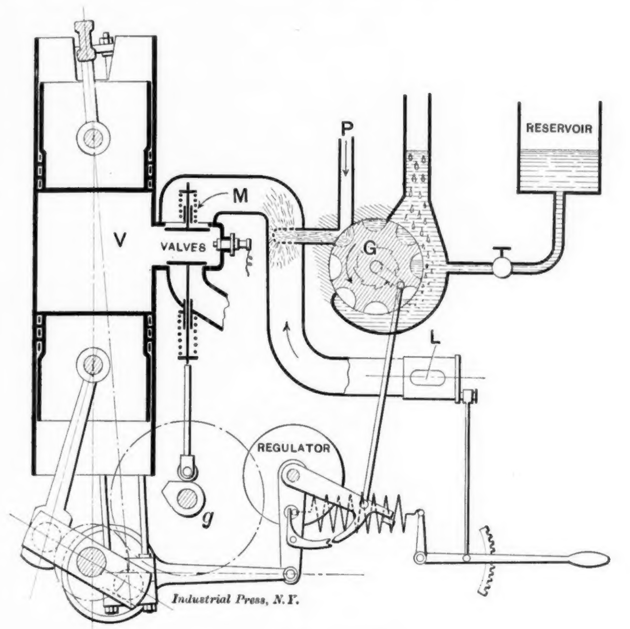


Fig. 3. Valve and Vaporizing Arrangement.

tric motion and as the connection between the weight and the shaft which gives it its motion is a flexible one (either by an intervening spring or by frictional contact) the inertia of the weight will cause it to travel ahead or lag behind its shaft, according as the engine speed retards or accelerates. This movement of the weight causes a dog which reciprocates with the eccentric to be thrown into or out of contact with a tappet attached to a lever which operates the ratchet mechanism. The inertia effect of the governor is modified by a spring, the tension of which can be adjusted by hand through the lever indicated at the lower right-hand corner of the engraving, and the speed of the engine varied from 300 to 1,400 turns a minute. It will be noted that the intake pipe *M* is prolonged downward and to the right for the admission of air through a valve at *L*, and to insure that the proper quantity is taken in to produce the combustion mixture the valve *L* is placed under the control of the hand lever mentioned above, so that when the speed of the engine is changed the volume of air is changed to correspond with the quantity of alcohol used under the new conditions.

The explosion of the alcohol and air mixture is less sudden than that of benzine, and the temperature of combustion is lower and better sustained. The same is true of carburetted alcohol as compared with benzine.

Chauveau's tests go to show that up to a speed of 1,000 turns per minute, carburetted alcohol gives out greater power than benzine; this difference, however, diminishes at greater speeds.

The products of combustion of alcohol have a less disagreeable odor than those of benzine. Being less volatile, it is hence less dangerous; and there is less waste in storage. This is of special importance in hot countries. Further, there are districts where benzine is difficult to procure because the steamship lines object to carrying it except in full cargoes and at excessive rates. Alcohol has the advantage of being procurable in agricultural districts by distillations from grain, potatoes, waste beet-pulp, etc., and can be manufactured with comparatively inexpensive apparatus.

At a meeting of the Hanover branch of the German Engineers' Society there was read a report by Prof. E. Meyer on alcohol motors. Tests with three Marienfelder motors gave as follows:

ALCOHOL PER HORSE POWER HOUR.

Motor I.	Lbs. av.
Full load, 23.36 H. P.	0.898
¾ load	0.968
½ load	1.115
¼ load	1.588

Compression 10 to 12 atmospheres; maximum cylinder pressure 28 atmospheres.

Motor II.	Lbs av.
Full load	0.935
¾ load	1.025
½ load	1.223
¼ load	1.879

Compression 12 to 13 atmospheres; maximum cylinder pressure 30 atmospheres.

Motor III.	Lbs. av.
Full load	0.867
¾ load	0.959
½ load	1.115
¼ load	0.582

Compression 13 to 14.5 atmospheres; maximum cylinder pressure 32 atmospheres.

This figures up, if we consider full load and take the caloric value of alcohol as 5,500 calories, to an efficiency of 28.7 per cent.

* * *

PROPORTIONS OF GEARS.

C. F. BLAKE.

In the February and March, 1902, issues of MACHINERY the writer gave such information as would enable a designer to determine the size of any gear, the form and strength of the teeth, and to lay out the tooth form. When designing a gear, however, there are other things of importance to be considered which were not touched in the above articles. These are the proportions of the rim, arms and hub. The number of arms in any gear is determined arbitrarily, and may be from three to eight, or even more, while many pinions too small to allow of arms between the rim and hub, must be made with solid webs.

Let R = the pitch radius of the gear in inches,
n = the number of arms,
W = the load at the pitch line = $s\,p\,f\,y$,*

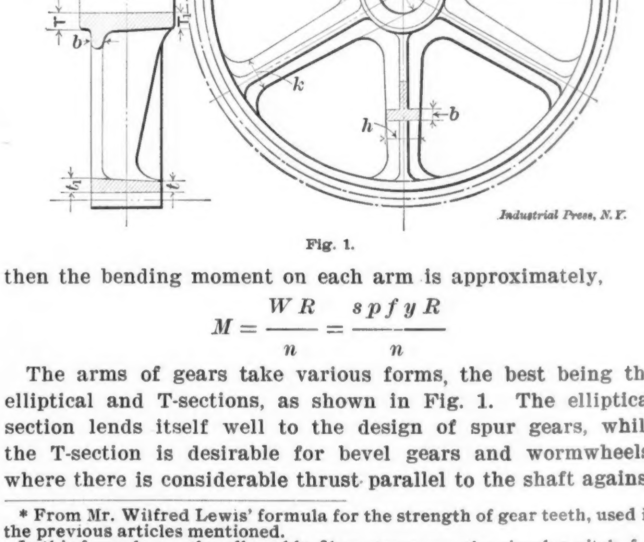


Fig. 1.

then the bending moment on each arm is approximately,

$$M = \frac{W R}{n} = \frac{s p f y R}{n}$$

The arms of gears take various forms, the best being the elliptical and T-sections, as shown in Fig. 1. The elliptical section lends itself well to the design of spur gears, while the T-section is desirable for bevel gears and wormwheels, where there is considerable thrust parallel to the shaft against

* From Mr. Wilfred Lewis' formula for the strength of gear teeth, used in the previous articles mentioned.
In this formula s = the allowable fiber stress, p = the circular pitch, f = the face, and y = a variable from the table given on the next page, where it is repeated for convenience.

which the gear must be stiffened, which is well accomplished by the rib of the T-section. In order that a gear shall mold well and produce a casting free from inherent strains, the metal must be well and evenly distributed, which may be accomplished by making $b = 0.6\ p$, where b is the thickness of the arm, as in Fig. 1, and p is the pitch of the gear. The proportions of the arm may then be as follows for,

Elliptical Sections.

Z = section factor.

$$Z = \frac{\pi}{32} b h^2 = .058 p h^2$$

$$M = S Z \text{ or } \frac{s p f y R}{n} = .058 p h^2 s$$

$$h^2 = \frac{f y R}{.058\, n}$$

$$A s R = \frac{n p}{2 \pi} = 16\, n p$$

we have

$$h^2 = \frac{.16\, n p f y}{.058\, n} = 2.7 f y p$$

and

$$h = \sqrt{2.7 f y p}$$

T-Sections.

Z = section factor.

$$Z = \frac{b h^2}{6} = \frac{.6 p h^2}{6} = .1 p h^2$$

$$M = S Z \text{ or } \frac{s p f y R}{n} = .1 p h^2 s$$

$$h^2 = \frac{f y R}{.1\, n}$$

$$A s R = \frac{n p}{2 \pi} = .16\, n p$$

we have

$$h^2 = \frac{.16 f y p n}{.1\, n} = .016 f y p$$

and

$$h = \sqrt{.016 f y p}$$

VALUES OF y.

No. of Teeth	Involute Teeth.	Radial Flanks.
12	.067	.052
13	.070	.053
14	.072	.054
15	.075	.055
16	.077	.056
17	.080	.057
18	.083	.058
19	.087	.059
20	.090	.060
21	.092	.061
23	.094	.062
25	.097	.063
27	.100	.064
30	.102	.065
34	.104	.066
38	.107	.067
43	.110	.068
50	.112	.069
60	.114	.070
75	.116	.071
100	.118	.072
150	.120	.073
300	.122	.074
rack	.124	.075

The dimension h is made to taper from the hub to the rim, and in elliptical sections the dimension b is also made to taper. This taper may be 7-16 inch to one foot for h, and 5-16 inch to one foot for b, the taper measured on the whole dimension.

The usual rim sections used with the above-mentioned arm sections are shown in Fig. 1, in which the dimensions are

$t = 0.47\ p$.

$t_1 = 0.56\ p$.

For bevel gears the thickness of the rim may be as shown in Fig. 2.

$t = 0.56\ p$.

Low and Bevis in their work on machine design give the following formula for the thickness of hubs, when made proportional to the diameter of a shaft which would have the same strength as the gear.

$$T = \sqrt[3]{\frac{f p R}{3}}$$

where f = the face of the gear,

p = the circular pitch,

R = the pitch radius.

The length of the hub is sometimes made the same as the face of the gear, but more often it is 1.5 times the diameter of the shaft. The taper of the hub may be ⅛ inch to one foot, and a boss should be placed over the keyway to make up for the metal taken out in cutting the keyway. An important method of increasing the strength of any gear is by means of shrouds or annular rings cast on the ends of the teeth as shown in Fig. 3. The strengthening effect of a shroud depends upon the face of the gear in inverse ratio, as while in all cases the shear between the shroud and the teeth is the same, it forms a greater ratio to the cantilever resistance of the tooth as the face becomes narrower. In practice,

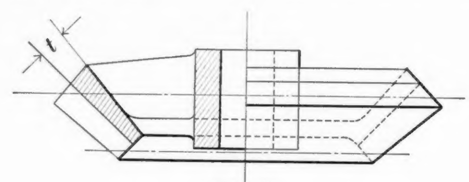


Fig. 2

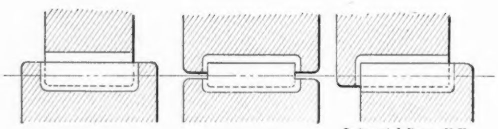


Fig. 3

pinions are more often shrouded than larger gears as, owing to the form of their teeth, they require shrouds to make them equal in strength to the meshing gear. As the teeth of shrouded gears cannot be finished or ground, plenty of clearance must be left between the shroud and the teeth of the meshing gear, as shown, in combination with different methods of shrouding, in Fig. 3.

* * *

THIRTY-SIX INCH TRIPLE-GEARED LATHE.

The triple-geared lathe, shown in Figs. 1 and 2, has just been brought out by the Bradford Machine Tool Co., Cincinnati, Ohio. In this tool are combined the leading features of the regular line of lathes manufactured by this company together with a number of new ones that have been added to increase the rigidity and wearing qualities and the ease of operation. The cone has five steps for 5¼-inch belt, the back gear ratio is 6.25 to 1, and the triple gear 40.61 to 1, thus giving 15 speeds, which are arranged in geometrical progression.

In the front of the bed, under the headstock (Fig 2) can be seen a nest of six gears, the lower three of which are drivers while the upper ones are keyed to the leadscrew. By means of a slip key controlled by a pin with a hexagon head, either set of gears may be brought into action, thereby giving three changes of feed or three different threads without changing the end gears. These changes, together with the usual change gears, give a wide range of threads. It is often found necessary to cut threads of very coarse pitch and outside of the range usually had on screw cutting lathes. For this purpose there has been incorporated into this lathe means where-

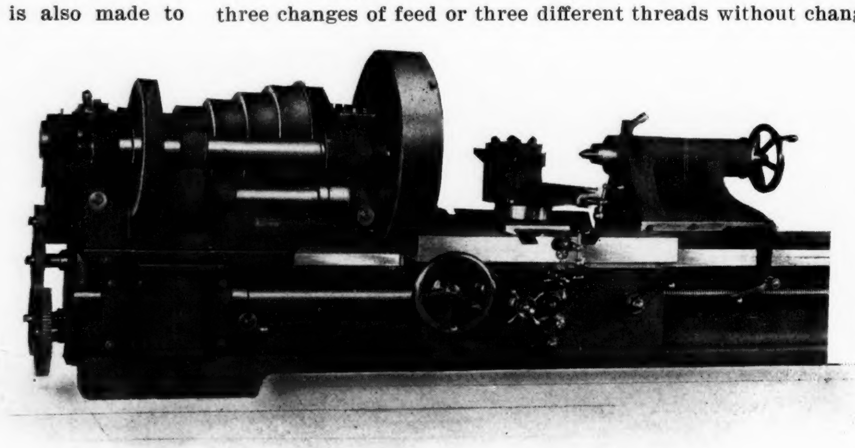


Fig. 1. Bradford 36-inch Triple-geared Lathe.

by this may be accomplished without any complications or compounding of gears. In the rear end of the headstock is a sliding bearing supporting a short shaft that has gears on either end. As they are shown, the inner gear is in mesh with a small gear on the cone and from the cone, motion is communicated directly to the screw. In this case the ratio is 8 to 1, when driven from the spindle, so that if the lathe is geared nominally to cut 1-inch pitch it would with this arrangement cut 8-inch pitch.

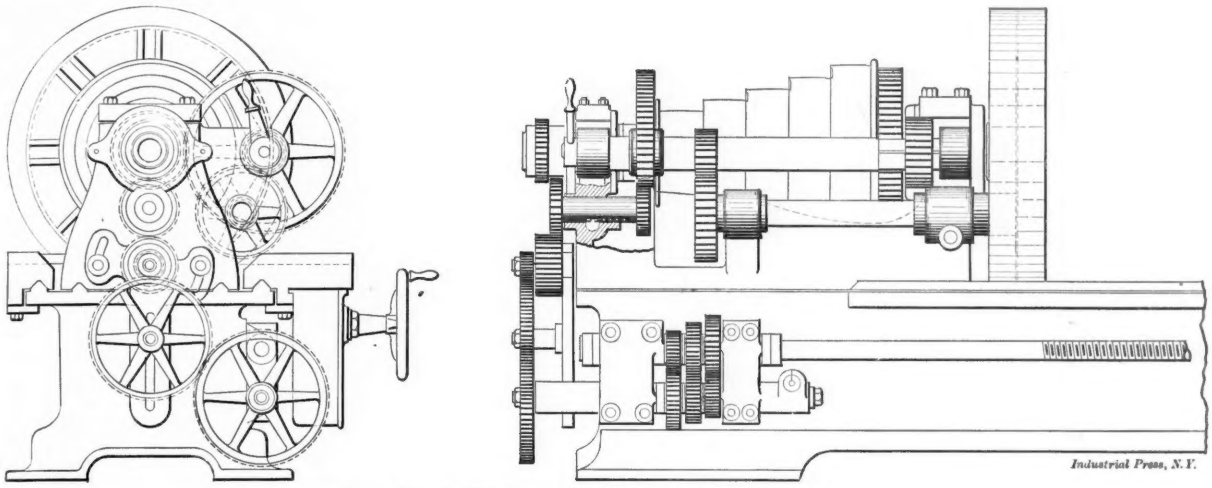


Fig. 2. Change Gearing of Bradford 36-inch Triple-geared Lathe.

The carriage is fitted with a compound rest which has power feed in all directions and the top slide has a motion of 12 inches. The apron is provided with a reverse and a simple non-interfering device which renders it impossible to engage more than one feed at a time. The leadscrew is cut with an Acme standard thread and splined its entire length, the threads being used only for screw cutting. The tailstock spindle has long movement and bears in the tailhead its full length. The tailstock as a whole is easily moved along the shears by a rack and pinion.

* * *

ORE HANDLING.

The wonders accomplished in the mining and handling of iron ore in the United States by the application of modern machinery are outlined in a special report to the British Government made by the Acting British Consul at Chicago, Mr. T. Erskine, a copy of which has been received by the Treasury Bureau of Statistics. The report is entitled "Report on the Iron Ore Industry of the United States," but gives especial attention to the modern methods of mining and handling ore, by which hand labor has been greatly reduced. In mining ore in certain parts of the Lake Superior region he says that the top covering of ground rock is scraped off over the whole property before mining begins. Railroad tracks are then laid direct to the ore bed, and the ore is loosened by blasting. Steam shovels are then brought into use and they load the ore directly upon the cars, one of these machines having loaded 170,000 tons in 26 days, or at the rate of over 6,500 tons per day. These loading machines, which daily handle more than 6,000 tons, are each operated by 5 men, and the labor cost for mining and loading averages but about 16c. per ton, and in the case of one mine, which dug and loaded 293,651 tons in 174 days, the labor cost was only 4c. per ton.

In the transfer of ore from mine to vessel on the Lakes the absence of hand labor is also noticeable. The ore trains are run onto long docks extending high above the water and having large pockets or compartments into which the ore is discharged from the cars through an opening in the bottom of the car, from which the ore runs by gravity into the pockets beneath the tracks. From these pockets the ore is loaded into the vessel, also by gravity, and passed down long chutes into the hold of the vessel so that no hand labor is required in transferring the ore from the cars to the vessel. The ore pockets or compartments, which form a part of the dock, hold about 160 tons each, and number from 90 to 384, according to the length of the dock.

In unloading the ore from the vessels the saving of labor through the use of machinery is even more notable and important in its economies and results. A series of steel bridges, so adjusted as to be easily moved along the docks, is supplied with a hinged arm, which can be lowered to the hatch of the vessel. Along this arm and across the bridge runs a trolley train to which are attached automatic "grabs" similar to a double scoop, which are so constructed that the grab or scoop digs downward into the ore as it closes. The grab or scoop holds about 5 tons of ore and is described as a "digging machine," as when it begins to draw together it digs into the ore and does not depend on its weight to get hold of the ore. There are 15 unloading machines in a battery, and the grabs run down the long arms which are lowered over each of the 14 hatches that are in the deck of most lake vessels carrying ore. These hatches run nearly the whole way across the decks. The grabs can thus remove over half the cargo without any assistance and the remaining half is brought directly under the hatch by use of a scraper also operated by similar machinery and managed by a man in the hold through the use of long cords. This scraper brings the ore from between the hatches so that it can be raised by the grab. These grabs are controlled by the engineer who can drop them at any point over the hold that he may wish and after it seizes its load of ore it is raised at full speed, carried rapidly along the trolley to such given point as desirable, where the ore is deposited into railroad trucks or stock piles, or in some cases into concrete troughs through which it slides to the furnaces, where it is to be transferred into pig iron. This grab, which thus lifts five tons of ore from the vessel carrying it to such point as is desired within a limited space, has a hoisting speed of 100 feet a minute, and can run along the bridge at the rate of 1,000 feet a minute. The operator travels with the grab and can unload it at any given point desired. The bridges to which these arms, with their grabs, are attached can be swung in any direction, so that ore, limestone, or coke can be deposited or picked up anywhere in the yard. They are worked by electricity. Twenty-six men will now perform, under this system, the work for which 300 were required under the old system.

* * *

Wrought iron and steel increase in tensile strength with increase of temperature up to 500 degrees F. Cast iron becomes perceptibly weaker at 200 degrees and at about 1,000 degrees it only has about one-third its normal strength at ordinary temperatures.

* * *

To find the heating surface required in feedwater heaters, a quick rule is to divide the known pounds of feedwater used per hour by 100 for copper, 90 for brass and 60 for iron pipe. The quotient will represent the required number of square feet of heating surface. This method of calculation applies particularly to the coil type of heater in which the circulation of feedwater is generally more rapid than in heaters of other types. This rule is based on authority of the Whitlock Coil Pipe Co.

THE COOLEY EPICYCLOIDAL STEAM ENGINE.

A NEW TYPE OF ROTARY ENGINE AND THE PRINCIPLE OF ITS CONSTRUCTION.

Without doubt no other type of steam engine has ever received the time and attention of hundreds of inventors that has been devoted to the attempt to produce a satisfactory rotary engine, and the number of patents that have been granted for

Fig. 1. Cycloidograph for Illustrating Principle of the Epicycloidal Engine.

different designs of this style of engine is exceedingly large. Upon trial, however, all, or nearly all, of these engines have failed to show any economy of steam production at all approaching that attained by the regular reciprocating engine. Many of the designs that seemed to possess promising possibilities have been so complicated as to be subject to excessive wearing of the operating parts so that in a short time they have become useless.

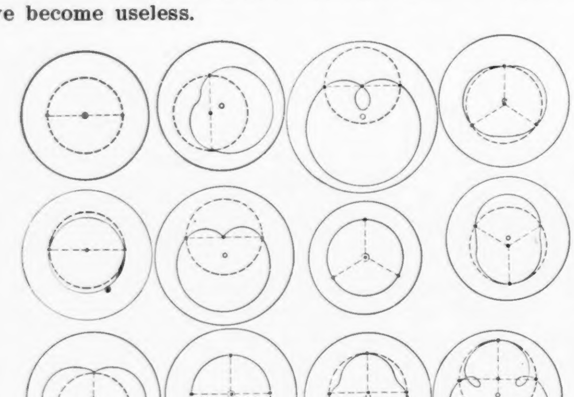


Fig. 2. Some of the Curves Generated with the Cycloidograph.

We illustrate herewith a type of rotary engine of unquestionably simple construction which constant trial for a period of over two years has proved to possess good wearing qualities, while reliable tests that have been made show that it is at least equal in the economical use of steam to the best reciprocating engines of the same capacities. This engine is the invention of Mr. J. F. Cooley and the patents are owned by the Cooley Epicycloidal Engine Co., who have established a thoroughly equipped laboratory at Allston, Mass., where the original engines have been built and the tests conducted. It is the plan of this company to establish branch shops in various parts of the country where the engines will be built for the different purposes for which they are adapted, while the Allston plant will be used for experimental purposes and for the construction of new types as they are designed.

This engine consists of a horizontal cylinder having at each end a bearing for the main shaft which runs directly through it, but whose center is eccentric with the center of the cylinder. Firmly fixed to the main shaft and revolving with it is a bilobed piston which, however, does not come in contact with the walls of the cylinder at any point in its revolution. The intervening space between the piston and cylinder is filled by

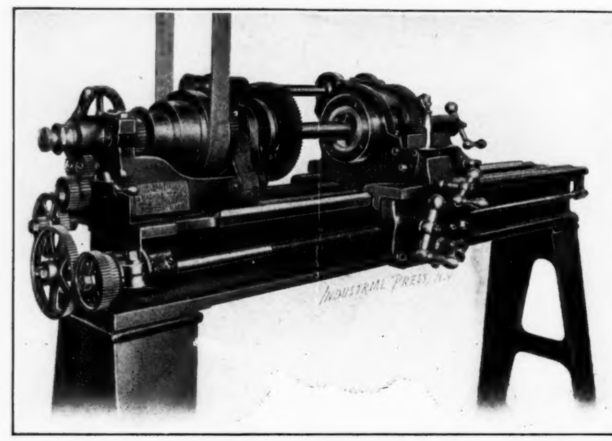


Fig. 3. Cycloidal Lathe Boring Trilobed Spacer of Epicycloidal Engine.

a ring, called a spacer, which has a series of longitudinal slots and bars that form ports and valves for the admission and control of the steam. Both piston and spacer revolve in the same direction but at different rates of speed.

To illustrate the principle upon which the invention is based, the cycloidograph, which is shown in Fig. 1, was designed. This consists of a number of points which are arranged so as to revolve about a plane which also rotates, in the same direction, but at a different rate of speed. The revolving points are supplied with markers and are turned by means of a crank shown at the top of the instrument. By varying the relative position of the centers about which the markers and the plane revolve, and also the relative speeds of rotation, any figure

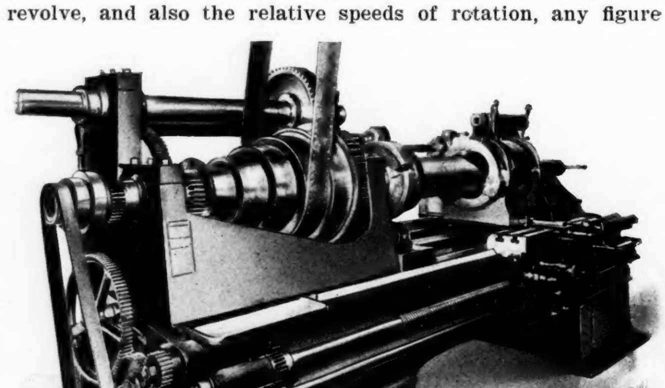


Fig. 4. Cycloidal Lathe Turning Bilobed Piston for Epicycloidal Engine.

may be described upon the plane, including circles, triangles, nephroid forms, etc. Now if a piece of metal be substituted for the plane and instead of the markers some form of cutting tool is used, it will be possible to cut from the metal a hole of any desired form. Again, if the cutters were stationed at the proper points on a revolving annulus rotated at the same rate of speed as the plane, and a piece of metal substituted for the markers the metal could be turned to any required form. These principles are employed in the construction of the epicycloidal lathes which were built for the purpose of turning the pistons and boring the spacers which are used in the engine.

Fig. 3 shows the lathe boring one of the spacers. The tool is held in a boring bar which is driven from the lathe spindle and rotates concentric with the centers of the lathe. The spacer which is being bored also rotates but at a different rate of speed and eccentric with the centers of the lathe. By making proper adjustments of the position of the centers and of the relative speeds of rotation, the tool will bore in the spacer a trilobed hole suitable to run with the bilobed piston which is shown in the process of being turned in Fig. 4. In this case the work is revolved on the lathe centers while the cutters,

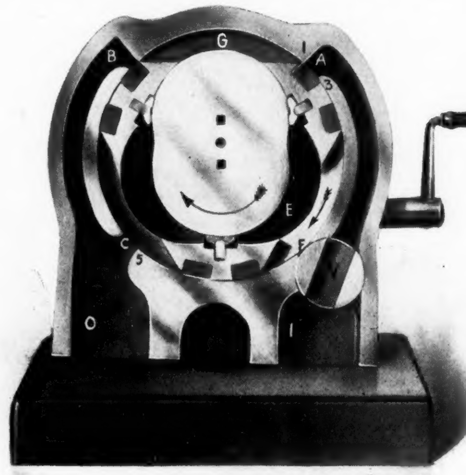


Fig. 5. Working Model of Epicycloidal Engine.

of which three are used, are revolved about a different center and at a different rate of speed. This action produces the bilobed piston which runs with the trilobed spacer after the form of a two-toothed pinion running in a three-toothed internal gear and the relative speeds are three revolutions of the piston to two of the spacer.

The action of the running parts of the engine and the method by which they are adapted to produce rotary motion are clearly shown in the model, Fig. 5. In this section *I* is the steam pipe and *O* the exhaust. Steam ordinarily enters at *A* and passes out through the exhaust port *C*. Both piston and spacer revolve in the direction indicated by the arrows and

TEST ON 10 H. P. ENGINE, MARCH 4, 1903.

Engine coupled to Dynamo.

Time.	Tank Weights.	Difference.	Boiler Pressure.	Vacuum in Condenser	Vacuum in Engine	Pressure at Engine.	Revolutions.	Volts.	Amperes
5 — 06	491.5	....	174	12.0	1.0	130	980	100.1	69.0
— 16	557.0	65.5	172	19.5	7.0	130	975	99.9	69.0
— 26	631.0	74.0	169	19.8	7.5	132	980	99.9	68.0
— 36	707.0	76.0	169	23.8	11.8	126	981	99.0	68.0
— 46	804.0	97.0	162	14.5	4.5	129	986	99.0	67.2
5 — 56	859.0	55.0	167	18.2	9.0	125	968	99.0	67.2
6 — 06	938.0	79.0	173	21.0	11.0	124	974	100.0	67.2
— 16	1014.0	76.0	172	22.1	11.0	122	976	100.0	67.1 67.1
— 26	1091.0	77.0	170	22.8	11.0	122	985	99.5 99.5	66.6 66.6
6 — 36	1166.0	75.0	168	23.0	11.0	119	...	99.0 99.0	66.0 66.0
Total...	......	674.5	1696	196.7	84.8	1259	8805	1193.9	875.0
Average	......	74.9	169.6	19.7	8.5	125.9	978.3	99.5	67.3

H. P. input to dynamo = 10.5 about 3% large.
Steam per H. P. hour = 42.83 lbs.

at relative speeds of three to two. In the position shown the engine is at its "dead point" and to start it in motion the valve *V* is rotated so as to allow steam to enter at the port *F*. As soon as the engine is started, however, this is returned to the position shown and all steam enters through the port *A*. Suppose now that the engine has started in motion so as to admit steam at the point 1 port *A*, into the chamber *G* which corresponds to the clearance space. As the motion continues, steam flows into the cylinder until the point 4 has passed the point 3, at which time cut-off occurs. As the piston and the spacer continue their rotation the intervening space between them gradually increases as shown at *E* and in this space expansion takes place. This continues until the point 2 has reached point 5 on the port *C*, when release occurs. Port *B* is an additional exhaust port which prevents any back pressure that might be caused by incomplete exhaustion through the port *C*. With this construction the horse power increases directly with the speed and approximately as the pressure of the steam used. There are no reciprocating parts and the

TEST ON 70 H. P. ENGINE, MARCH 14, 1903.

Barometer = 30.00 ins. Room Temperature = 80° F.

Time.	Tank Weights.	Difference.	Boiler Pressure.	Vacuum in Condenser	Vacuum at Engine.	Pressure at Engine.	Counter Reading.	R. P. M.
3 — 12	521	..	126	22.6	18.6	90	3 — 14	....
— 17	586	65	159	20.0	17.5	88	207,950	....
— 22	659	73	133	19.2	16.8	90	....	702
— 27	721	62	165	19.5	17.2	87	....	....
— 32	787	66	140	19.6	17.0	90	3 — 34	....
— 37	852	65	159	19.4	17.0	90	221,990	....
— 42	920	68	154	20.0	17.2	93	....	696.5
— 47	986	66	150	19 2	16.9	90	....	....
— 52	1052	66	172	20.8	18.1	90	3 — 54	....
— 57	1121	69	163	21.0	18.5	91	235,920	....
4 — 02	1188	67	155	20.8	18.0	90	....	698.5
— 07	1254	66	165	20.9	18.2	90	4 — 14	....
— 12	1320	66	...	.	18.3	90	249,890	....
Total or Average	799	799	154	20.3	17.6	89.9	....	699

H. P. output of engine = 25.6.
Steam per H. P. hour = 31.2 lbs.

speed can be varied at will from that of the slow speed reciprocating engine up to that of the high speed steam turbine. Governing is accomplished wholly by throttling, the point of cut-off remaining constant at all speeds.

As an example of the comparative size of these engines, a 10 horse power engine, running at a speed of 2,000 revolutions, measures but 14 inches long, is 6½ inches high, 5 inches thick and weighs only 45 pounds. Fig. 6 shows a 10 horse power engine direct connected to a 4-pole, 6-kilowatt generator running at a speed of 950 revolutions per minute. In this case it has the appearance of a good-sized outboard bearing. The accompanying tables show the results of a series of tests that were performed by Professor E. F. Miller, of the Massachusetts Institute of Technology. The engines so far tested have been neither compounded nor jacketed, and it is anticipated that when the jacketed compound engines are tested, very much better economy will be attained.

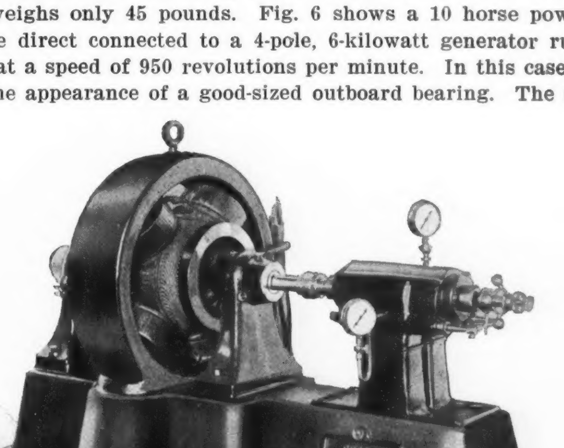


Fig. 6. Ten H. P. Epicycloidal Engine Direct-connected to 6-KW. Generator.

The engines are also built of the reversing type and owing to their extreme compactness are well fitted for marine and automobile work. One of these engines, running a propeller immersed in a tank of water, is often instantly reversed from full speed ahead to full speed astern without injury to the engine.

ENGINEERING REVIEW.

CURRENT EVENTS, TECHNICAL AND MECHANICAL—LEADING ARTICLES OF THE MONTH.

At the annual meeting of the stockholders of the Pennsylvania Railroad Company held recently, when they voted to increase the capital stock from $250,000,000 to $400,000,000 Vice-President J. P. Green said that during the past two years the company has purchased an average of one locomotive a day and a total of 40,000 freight cars.

The city of Chicago is following the lead of Cleveland, St. Louis, Washington and other cities in the matter of smoke suppression, a question that has been agitated by the *Chicago Times-Herald* for a long time, apparently with good results. The city council has passed a smoke ordinance which puts the work of smoke inspection and boiler inspection in one department. All plans for steam plants must be examined and approved of before a permit for the erection of the buildings can be issued by the building department.

A French patent has been taken out by the De Dion-Bouton firm on a self-ignition device for internal combustion motors. A small cylinder is fastened to the side of the working cylinder with a port connecting the two. The piston of the small cylinder reciprocates at one-half the rate of that of the larger one, that is for two strokes of the main piston the auxiliary piston makes one stroke. An explosive mixture is drawn into the small cylinder on its down stroke, and this is compressed to such a degree on the up stroke that it spontaneously ignites and fires the charge in the working cylinder, the flame communicating by the port referred to.

Because of the notable achievements in utilizing the water power from the glaciers in the Alps between France and Switzerland a "white coal" convention was recently held at Grenoble, France, which was attended by over 500 prominent engineers. At Epirre, Savoie, a fall of 1935 feet is utilized; at Chapareillan, 25 miles from Grenoble, another fall of 2,040 feet has been utilized; Grenoble will soon be lighted by water power; and many other industries too numerous even to mention are now deriving their power from the mountain streams fed by the snow fields and glaciers of the Alpine mountain system. Of course what has made all this so recently possible, is long distance electrical transmission.

The first annual report of the National Bureau of Standards has been issued and reviews the work incident to organizing the departments and announces the plans for the future. Two buildings have been planned, one of which, the mechanical laboratory, is now under construction. It will include a boiler room, engine and dynamo room, a refrigerating and liquid air plant, storage battery room, rooms for heating and ventilating apparatus, and instrument shop, wood carving department, and a room for conducting electrical tests requiring heavy currents. The second building will be for a physical laboratory and contain apparatus that must be removed from the vibration and magnetism of machinery. Plans have been developed for carrying on several lines of work in the near future, such as standardizing lengths up to 10 feet, measurements of volume, electrical resistances, etc. In thermometry, preparations are being made to test temperature measuring instruments extending over a range from minus 140 degrees to 2,700 degrees F.

The distance between Wilkesbarre and Hazelton, Pa., is a matter of about 50 miles by either the Pennsylvania Railroad or the Lehigh Valley Railroad. A new electric third-rail line has been built between these two points which is only a little more than one-half as long, its length being 26 miles. This road is notable not only because of its permanent construction —stone bridges, deep rock cuts, heavy fills, tunnel through solid rock 2,600 feet long, 95-pound rails and avoidance of all grade crossings—but for the adoption of a hooded third-rail which, of course, prevents accidents to the workmen, but it was primarily adopted to prevent interference from winter storms. The third-rail is supported on the end of every fifth tie, which is made longer than the other four, and over the rail is placed a pine plank 2 x 6 inches, supported every 8 feet by oak posts, both the rail and the plank being supported on insulators. The third-rails are 60 feet long and weigh 80 pounds to the yard. The severe storms of last winter proved the efficiency of the protection, as otherwise it would scarcely have been possible to run the cars with any regularity at some of the worst periods.

The problem of towing canal boats by power has been receiving attention in Germany and experiments upon several types of towing machines are in progress. The main trouble experienced in towing by means of a steam or electric car running on rails along the tow-path comes from derailing whenever there is a sudden jerk upon the tow line, owing to the impossibility of keeping a uniform tension in the line. To overcome this an electric towing car has been designed by Messrs. Ganz & Co. The car is relatively light and has two pairs of wheels which are set at a convergent angle, so that both pairs run on the same rail, the balance of the machine being maintained by a pair of trail wheels running along the adjacent roadway. Almost the entire weight, however, is borne by the inclined wheels on a single rail, and the arrangement is such that the heavier the resistance load created by the boat, the tighter the grip of the wheels upon the rail.

It is proposed to equip a new canal 23 miles in length, south of Berlin, with this or some other system of electric towing. For an annual traffic of 1,500,000 tons 53 locomotives will be required, each capable of towing one boat of 600 tons or two boats of 200 tons.

The American Institute of Electrical Engineers have taken an important step, in line with the progressive management which has characterized this society, by the creation of a "student" grade.

This does not correspond to the "Junior" grade of the Civil and Mechanical Societies, but is intended for students at the technical schools or elsewhere. The sole requirement of applicants for such student membership is that they shall be "regularly pursuing electrical studies." Such men on suitable indorsement, may on payment of $3 per annum become students of the institute, and as such will receive the regular announcements and monthly "Transactions," and may attend any meetings of the Institute except business meetings. They may also purchase the semi-annual bound volumes of "Transactions" at $3.50 per volume. The continuance of such student membership is limited to not more than three years in any case. In connection with the local meetings of the Institute now held at fourteen prominent engineering schools, it will doubtless serve to make the Society known to a large number of young engineers and a considerable proportion of these will be apt to apply for membership in later years.

While public interest in the possibilities of electric automobiles has centered in the Edison battery, it must not be forgotten that marked improvements have been made in others, all of which are leading to a certain increase in popularity of electric vehicles. The *Western Electrician* reports a new alkaline storage battery exhibited at the Chicago automobile show that attracted a good deal of attention. The exhibit consisted of 28 cells, each weighing slightly less than six pounds and is said to have a capacity of 100 ampere-hours on a closed circuit of 1.4 volts per cell. These were connected to a light runabout mounted on a speedometer and a switchboard, the whole being arranged to demonstrate the possibilities of the new battery. The runabout, on a test made during the exhibition, required 30 amperes to drive it a speed of 20 miles an hour, and the battery was able to deliver this amount of current for three hours continuously. Each cell is hermeti-

cally sealed, and therefore it becomes unnecessary to standardize the specific gravity of the solution, and the spilling of the acid or electrolyte is prevented. The efficiency of the battery compares favorably with lead cells, and it is particularly attractive to the operator of an electric vehicle because he can give practically full charge to his batteries in an hour or two and discharge them at such a rate as conditions may require, without any danger to any part of the batteries. The cost of this cell is stated to be slightly above that of the lead cell.

At the sixth annual general meeting of the Marconi Wireless Telegraph Co., held March 31, in London, the chairman gave a short running account of the progress of the company during the year and said that the past eighteen months had been a period of the greatest activity, during which substantial progress had been made in the development of the system and the establishment of new stations. In referring to the attitude of various countries he stated that the Italian government had given them the heartiest support. In this connection Mr. Marconi stated that the Italian government had authorized him to construct a large station in Italy for the purpose of communicating with America; also that they had agreed to use no other wireless system of telegraphy for commercial purposes during the next fourteen years. In regard to the existing cable companies and their enmity he said that ever since 1897, when he first succeeded in communicating from England to France without wires, the cable companies had not ceased to regard his efforts as a menace to their interests and to endeavor by ridicule, misrepresentation and other means to discourage his progress. Regarding the statements that have been so widely circulated that interference between adjacent stations would surely prove an insurmountable bar to commercial work, he quoted from the report of Prof. Fleming, who has made an exhaustive investigation of the subject in the Marconi station at Poldhu. In Prof. Fleming's opinion the problem of interference has been satisfactorily solved and the statements to the contrary are not based on fact. The signals sent from Poldhu did not interfere in the slightest with the local wireless system for signaling to ships.

The many railroad accidents during the past year in the United States have led to an investigation by our consular officers of the methods employed by European railways to avoid disasters. Among the reports received at the State Department is one from Consul-General Mason, at Berlin, in which he tells of a new device which is being tested by some of the German railroads.

A light T-rail is laid between the rails, and midway under the engine is hung an electrical apparatus connected with a contact shoe which slides along the third rail. Wires connect with a telephone and an electric alarm bell in the cab, also with a red incandescent lamp which is lighted by the same impulse that rings the alarm bell. The device sets the electric brakes simultaneously with the alarm. The apparatus is so adjusted that the engineer can at any minute by touching a lever satisfy himself that it is working.

Numerous tests have been conducted. In one instance an engine drawing a special train at full speed received a danger signal and came to a full stop. The engineer then asked by telephone the cause of the signal and received from the keeper of a grade crossing, half a mile in front, word that a wagon had broken down in crossing the track and obstructed the line. After ten minutes' wait the engineer received word by telephone that the obstruction had been cleared away and resumed his trip.

Bearing on this subject is a recent report of the Illinois Railroad Commission, giving some statistics of derailments at interlocking grade crossings of railways in the State of Illinois for the past year, from which it appears that while, out of a total of 197 derailments only 7 were due to defects in the interlocking system, and 27 to defective track or rolling stock, no less than 138 derailments were due to trains running against the signals. In view of these statistics the Commissioners recommend the use of an automatic stop, acting directly upon the engine.

APPLICATION OF REVERSING ELECTRIC MOTORS TO PLANERS.

Mechanical World, April 10, 1903, p. 178.

The writer, Harold C. Gunson, refers to the fact that in the usual application of electric motors to planing machines, the motor is employed to drive the countershaft, or the driving pulleys are placed directly on the motor shaft and the reversing of the table accomplished by the usual mechanical means. This method of driving a planing machine has several disadvantages, chief among which is the very heavy current taken on reversing. This is sometimes overcome by means of a heavy flywheel on the motor shaft; but unsatisfactorily. The wear and tear of the belts and the tappet motion are also considerable, not to speak of the noise produced.

He then mentions the advantages of obtaining the reversal of the table by reversing the direction of the motor itself, saying there is no reason why a well-made motor should not be able to withstand a reversal every few seconds continuously, if the current in the armature when slowing down and getting up speed again is not allowed to exceed, say, double the full-load current. The motor—which should be shunt-wound—may be connected by means of a belt to the driving shaft of the planing machine, or it may be arranged to drive directly through the gearing. In the former case the motor is protected from overload by the slipping of the belt, and there will be less shock to the gears. This arrangement is therefore preferable, although it adds to the weight of the rapidly-revolving parts. The reversal is effected by a reversing switch actuated by the rocking shaft, in conjunction with a device for switching in resistances while the motor is slowing down to zero and getting up speed again, which is controlled by the current in the armature circuit.

In slowing down, the motor acts as a generator, the fields being constantly excited from the mains, and the current produced is passed through properly-regulated resistances which do not allow it to exceed some predetermined amount, until the armature comes to rest. Then the current is switched on in the opposite direction, and the amount through the armature regulated in the same way until it attains full speed. This piece of mechanism is the subject of a patent, and works exceedingly well. Quick return is obtained by weakening the field on the return stroke, a ratio of 3 to 1 being obtained with some motors. A separate starting switch is provided, and a field regulator for giving various cutting speeds to suit the different classes of metal operated upon.

This arrangement works smoothly and silently, and the driving bracket can be much reduced in size, as there is nothing on it but one pulley and the gearing. There is also much less wear and tear on the tumbler and other parts working in connection with it, which has practically nothing to do but operate the feed mechanism. It is, of course, advisable to reduce the kinetic energy of the moving parts which require reversing in direction, especially those that move the most rapidly. These are the armature and the pulleys. Therefore a slow-speed motor is the best for this purpose. The pulleys should not be of the high-velocity narrow-belt type, which is necessary when the belt has to be moved rapidly from one pulley to another. They should be reduced in diameter and increased in width so as to transmit the power required with as low a peripheral speed as possible. There is no difficulty, when the motor is running on the return stroke and the table moving at, say, 60 feet per minute, in bringing it to rest in as short a space as is necessary by increasing the field to its maximum strength while slowing down, thus obtaining a very powerful torque without an excessive current through the armature.

With regard to the use of induction motors, it will be more difficult to apply them to work of this kind, but with a little experimenting the three-phase motor may be found suitable. The direction of rotation of the field will have to be reversed while the motor is going at full speed, and resistances inserted in the rotor circuit in order to obtain sufficient torque, which must be gradually cut out as it slows down and gets up speed again, by an arrangement controlled by the current in the rotor circuit, in a manner similar to the direct-current

motor. The quick return can be economically obtained by reducing the number of poles by means of a switch. The different cutting speeds requiring small variations in the speed of the motor may be obtained by resistances in the stator or rotor circuits, at the expense, however, of its efficiency.

APPARATUS FOR INSPECTING THE INTERIOR OF BOILER TUBES.

Le Genie Civil.

The specifications for boiler tubes usually require that the inside and outside surfaces shall be smooth and free from pitting and other defects and yet there is no attempt at inside inspection.

An instrument designed by M. J. Vinsonneau and made by Secretan, of Paris, makes such an inspection both possible and rapid. It consists, as shown in Figs. 1 and 2, of a tube *A* formed of several sections screwed together or telescoping into each other and painted white on the inside. An incandescent lamp *B*, with its reflecting mirror embracing it, illumines a section *m m*, of the interior of the tube. The image of

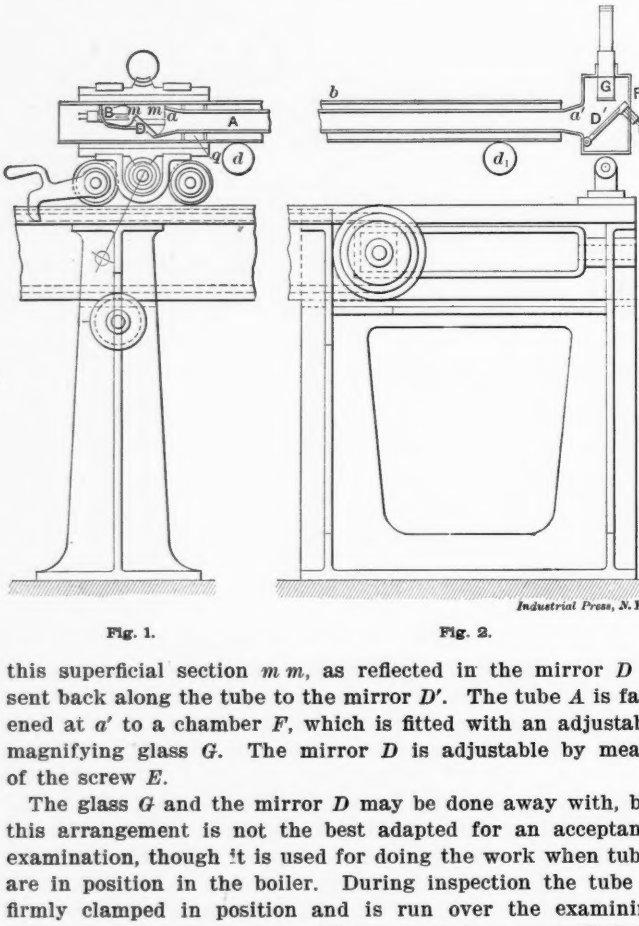


Fig. 1. Fig. 2.

this superficial section *m m*, as reflected in the mirror *D* is sent back along the tube to the mirror *D'*. The tube *A* is fastened at *a'* to a chamber *F*, which is fitted with an adjustable magnifying glass *G*. The mirror *D* is adjustable by means of the screw *E*.

The glass *G* and the mirror *D* may be done away with, but this arrangement is not the best adapted for an acceptance examination, though it is used for doing the work when tubes are in position in the boiler. During inspection the tube is firmly clamped in position and is run over the examining tube by means of gearing, either operated or controlled by the inspector, and the fastening arrangements are such that a tube can be rapidly and easily removed and replaced.—G. L. F.

USE OF SUPERHEATED STEAM IN STATIONARY PLANTS.

Zeischrift des Vereines Deutscher Ingenieure.

M. Hunger presents a paper relative to the modifications that must be made in boilers and engines when superheated steam is to be used.

The author calls attention to the fact that he was one of the promoters of the use of superheated steam in Germany, and recalls the numerous trials, the first of which were unsuccessful, that were made at the Gritzner Works at Durlack. The lack of success at the beginning was due to the necessity of changing the boilers and machines used. In the boilers it was necessary to increase the dimensions of the shell and do away with the vertical headers which were fragile and of low thermal efficiency. Superheaters should be made of tubular elements which can be put out of service when necessary. The steam engines should be fitted with cylinders especially constructed for the use of superheated steam, and the various details such as stuffing boxes and the like should have a different design from those ordinarily used. Mr. Hunger shows how these necessary modifications have been made and executed along lines that have seemed most favorable. He describes a number of boilers and engines of recent construction and shows how the steam consumption in each has been improved by the use of superheated steam. G. L. F.

LARGE ARMORED CONCRETE CHIMNEY.

Engineering News, April 2, 1903, p. 308.

A Ransome armored concrete chimney 180 feet in height, 15 feet in diameter at the top, and having a flue 11 feet in diameter, has recently been built at Los Angeles, California, for the new power house of the Pacific Electric Railway Co., which has a network of suburban electric roads centering in that city.

The chimney was built under the Ransome system, with a thorough reinforcement of square, cold-twisted steel bars, both vertically and horizontally in each shell. The horizontal reinforcement consists of rings of ¼-inch steel twisted bars, placed at intervals averaging 18 inches in the inner shell and 24 inches in the outer. Vertical bars of ¾-inch square steel, twisted, were placed 1 foot apart in the lower third of the stack above the flues, 2 feet apart in the middle section, and 4 feet apart in the top section of the outer shell. In the inner shell ¼-inch bars were used, spaced about 3 feet apart in the circumference of the work.

The original design of the chimney contemplated a straight shaft, 15 feet in diameter, throughout, from the base up. Subsequent alterations in the plans of the boiler house, changing the relative positions of boilers and chimney necessitated the provision of the two flue openings on opposite sides instead of one. The extra opening thus provided would have materially reduced the sectional area of the chimney at this point, and it was deemed necessary to increase the size to 18 feet for a height of 45 feet above the base. Above that point the chimney was built circular in form 15 feet in diameter. This change in diameter and form made it necessary to build a special mold for the lower section, which was rendered more difficult by the square projections of the flue openings, extending from the foundation up.

The mold was clamped together, or loosened when it was to be raised, by turnbuckles. During the time that this base section was being built the mold for the exterior of the circular part had to be pushed up ahead of the work, and supported on the scaffold by which the interior mold was raised, and from which all of the work was done. This obviated the necessity of building the 15-foot mold around the scaffolding 45 feet up in the air. This interior scaffold was kept ahead of the work all the time, and the exterior molds, when loosened, were raised 10 feet at a time by the suspending screw-rods, and hand wheels, from which they were hung to the head scaffold. The inner mold and cores were raised 5 feet at each setting, and concrete to the height of 5 feet was placed each day.

The entire construction was carried on from the interior, and all material was hoisted up the shaft by an electric hoist. All the scaffolding was built inside, and consisted of four 4 inch by 6 inch timbers for uprights, with 2 inch by 10 inch horizontal braces bolted thereto every 5 feet and 1 x 6-inch cross braces. The head, or top, scaffold was formed of 6x14-inch timbers to which the hoisting rods were attached. To obviate the labor of dismantling this head scaffold with each setting of the molds, a telescope scaffold was built inside the main upright scaffold which enabled the workmen to disconnect the head scaffold, raise the entire head intact and put in extensions to the uprights, all of which could be done in 2½ hours.

The chimney contains approximately 20,000 cubic feet of concrete, and 850 barrels of cement were used in its construction. The steel embedded in the concrete consists of 10,000 pounds of twisted bars, and 4,000 pounds of old rails, which were placed 12 inches apart, in two layers in the base. The weight of the chimney is approximately 1,430 tons, and the

distributed load on its base less than two tons per square foot. Other concrete steel chimneys have been built under the Ransome system, among which is one at Constable Hook, N. J., for the Pacific Borax Co. 150 feet high; one at Jersey City, N. J., for the Central Lard Co., 108 feet high; and one for the Singer Sewing Machine Co. at Elizabethport, N. J., 125 feet high.

THE CURTIS STEAM TURBINE.

Abstract from Paper read before the American Philosophical Society at Philadelphia, April 2, 1903, by W. L. R. Emmett.

The paper states that the first patent application of C. G. Curtis for an elastic fluid turbine was made in 1895. (The first patent issued to Curtis, we believe, is No. 566,967, date September 1, 1896.) The rapid development of the inventions of Curtis and the placing of them on a commercial basis is evidenced by the fact that the General Electric Company, Schenectady, N. Y., now have contracts for building over 230,000 horse power of steam turbine electric generators. The largest so far built is 7,500 horse power for a power plant in Chicago.

The author says the idea of the steam turbine is quite simple and is similar to that of the water turbine or impulse wheel. The practical difficulty which has heretofore prevented the development of good steam turbines lies in the very high velocity which steam can impart to itself in expansion, and the difficulty in efficiently transferring this motion to wheels at speeds practicable for construction or practical use. Steam expanding from 150 pounds gage pressure per square inch into the atmosphere, is capable of imparting to itself a speed of 2,950 feet per second, and if it is expanded from 150 pounds gage pressure into a 28-inch vacuum it can attain a velocity of 4,010 feet per second. The spouting velocity of water discharged from a nozzle with 100-foot head is 80 feet per second. These figures illustrate the very radical difference of condition between water turbines and steam turbines. In both water and steam turbines the theoretical condition of maximum economy exists when the jet of fluid moves with a velocity equal to about twice that of the vane against which it acts. In water-wheels this relation is easily established under all conditions, while with steam the total power produces a velocity so high that the materials available for simple wheels and vanes are not capable of sustaining a proper speed relation to it under practicable conditions.

The author then briefly describes the principle of operation of the three leading types of steam turbines, viz., De Laval, Parsons and Curtis (see MACHINERY for November, 1902). In reference to the Curtis machine he says that it retains some of the features of its predecessors, but introduces features that make possible lower speed, less weight, higher economy, less cost, etc. Velocity is imparted to the steam in an expanding nozzle so designed as to efficiently convert nearly all the expansive force, between the pressure limits used, into velocity in the steam itself. After leaving the nozzle the steam passes successively through two or more lines of vanes on the moving element, which are placed alternately with reversed vanes on the stationary element. In passing successively through these moving and stationary elements the velocity acquired in the nozzle is fractionally abstracted, and largely given up to the moving element. Thus the steam is first thrown against the first set of vanes of the moving element, and then rebounds alternately from moving to stationary vanes until it is brought nearly to rest. By this means a high steam velocity is made to efficiently impart motion to a comparatively slowly-moving element. The nozzle is generally made up of many sections adjacent to each other, so that the steam passes to the wheels in a broad belt when all nozzle sections are in flow. The governing is effected by successive closing of nozzles and consequent narrowing of the active steam belt. Fig. 1 shows part of the nozzle open and part closed, the arrows showing space filled by live steam.

Among the drawings accompanying the paper were elevations and plan of the 500-kilowatt Curtis turbines installed in the Newport, R. I., station of the Massachusetts Electric Companies. (See MACHINERY for March, 1903, p. 375.) Curves were also introduced showing the record of tests made on a turbine driving a 600-kilowatt generator at a speed of 1,500 revolutions per minute. The consumption at a pressure of 140 pounds, 28.5 inches vacuum and no superheat was about 19.2 pounds at 600 kilowatts and 19 pounds at 750 kilowatts.

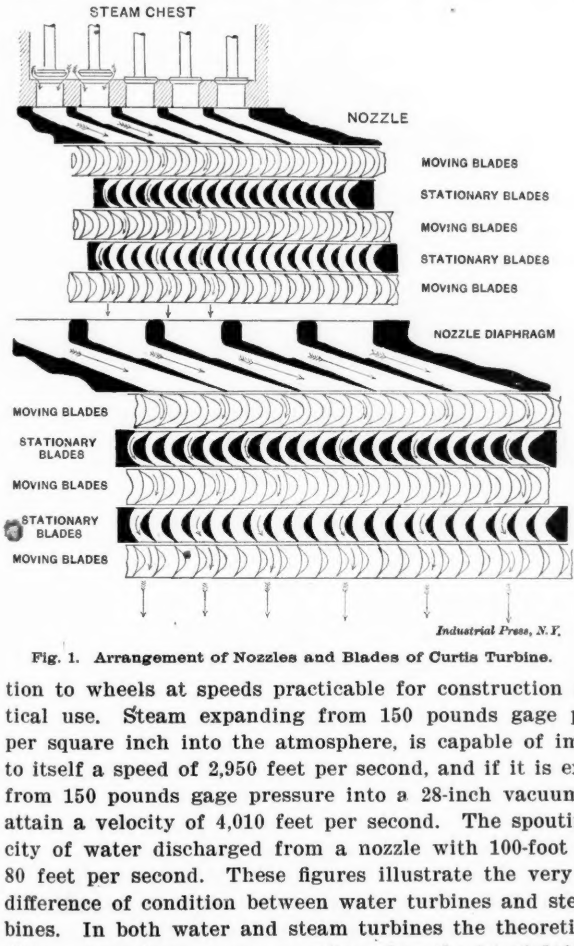


Fig. 1. Arrangement of Nozzles and Blades of Curtis Turbine.

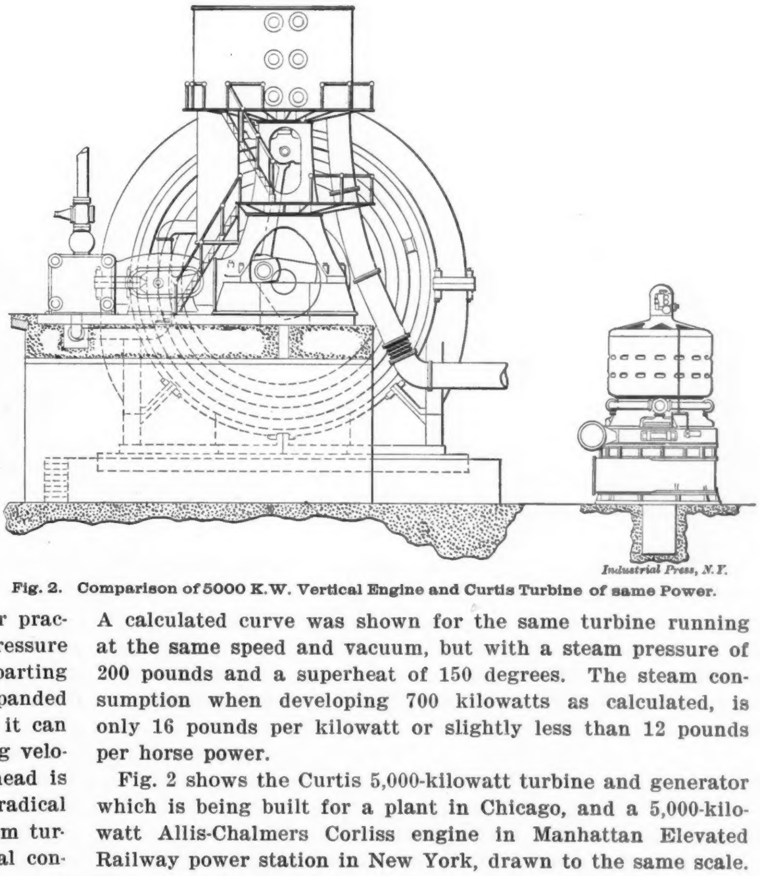


Fig. 2. Comparison of 5000 K.W. Vertical Engine and Curtis Turbine of same Power.

A calculated curve was shown for the same turbine running at the same speed and vacuum, but with a steam pressure of 200 pounds and a superheat of 150 degrees. The steam consumption when developing 700 kilowatts as calculated, is only 16 pounds per kilowatt or slightly less than 12 pounds per horse power.

Fig. 2 shows the Curtis 5,000-kilowatt turbine and generator which is being built for a plant in Chicago, and a 5,000-kilowatt Allis-Chalmers Corliss engine in Manhattan Elevated Railway power station in New York, drawn to the same scale. The respective weights exclusive of the foundations are as 1 to 8 and the saving in foundations alone is an important item. The simplicity of the turbine is in marked contrast to the complication of these excellent engines, which now apparently belong to a past era. It has been estimated that if engine units like those of the Manhattan station were replaced by Curtis turbines, the cost of such replacement will be paid for by the saving effected in three years.

THE TOMSON BOILER.

Der Praktische Maschinen Konstrukteur, Jany. 1, 1903, p. 2.

The boiler, as shown in the cut on the next page consists of two corrugated flue boilers, set upon either side, and combined with a water tube boiler, upon which a steam drum is placed.

In the construction of the flue portion of the boiler, the heads are bumped and flue is set in it in the usual manner. Upon the top of each of the flue boilers there is placed a steam dome 27½ inches in diameter and 26½ inches high, the diameter of the shell itself, in the boiler shown, being 71 inches. The feed pipe enters through the back sheet of each flue boiler

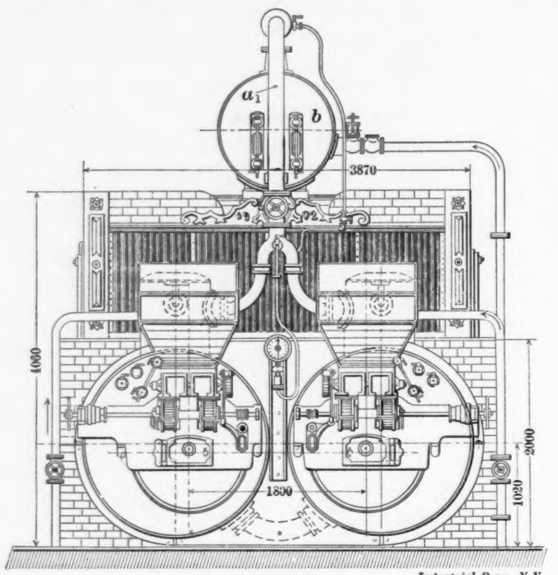


Fig. 1. End View of Boiler.

while the blow-off cock is set in the bottom of the middle sheet. The two central sheets of the flue boiler are also connected near the bottom by a curved pipe, as shown by the dotted lines of the front elevation. A steam gage is set upon the dome from the top of which there is also a pipe, A_1, leading into the steam space of the drum on the water tube boiler. In this firebrick bridge wall. In the front elevation of the boiler, as shown in the engraving, automatic stokers are in position.

The flue section of the boiler is located in front of the water-tube portion. The latter is double chambered and is of the ordinary construction with welded headers into which the tubes are expanded. These headers are also connected with the steam drum outside the brickwork. This steam drum, in the special boiler under consideration, is formed of five courses, and has a total length of 20 feet 9 inches including the curvature of the heads.

The circulation of the water in the water-tube section of the boiler starts from the feed valve *E*, whence by means of the pipe E_1, the proper portion of the feed water is led off into the upper drum, where it parts with most of its scale. This is carried back and deposited in the mud-drum *C*, whence it is regularly washed out through the pipe C_1. The water, thus purified, settles down through the water leg *D* into the back header, from which it enters the tubes. Here the usual evaporation takes place under the influences of the hot gases, and the circulation causes a mixture of steam and water to be discharged into the front header. From this it rises up to and into the horizontal pipe B_1 that has already been described, where a separation of the steam and water finally takes place. The steam, thus generated and discharged into the steam drum, at last enters the dry pipe *F*, and passes off through the valve F_1 to the engine. Finally the scale collecting in the bottom of the back header is blown out at regular intervals through the pipe C_2.

Since the flue portions operate as perfectly independent boilers with their own steam domes, they are provided with their own glass water columns, water gages and safety valves. The combustion of fuel in these boilers is carried on in this way: The hot gases rising from the burning of the fuel on the grates in the corrugated flue, impart a portion of their heat to the water surrounding it and convert the latter into

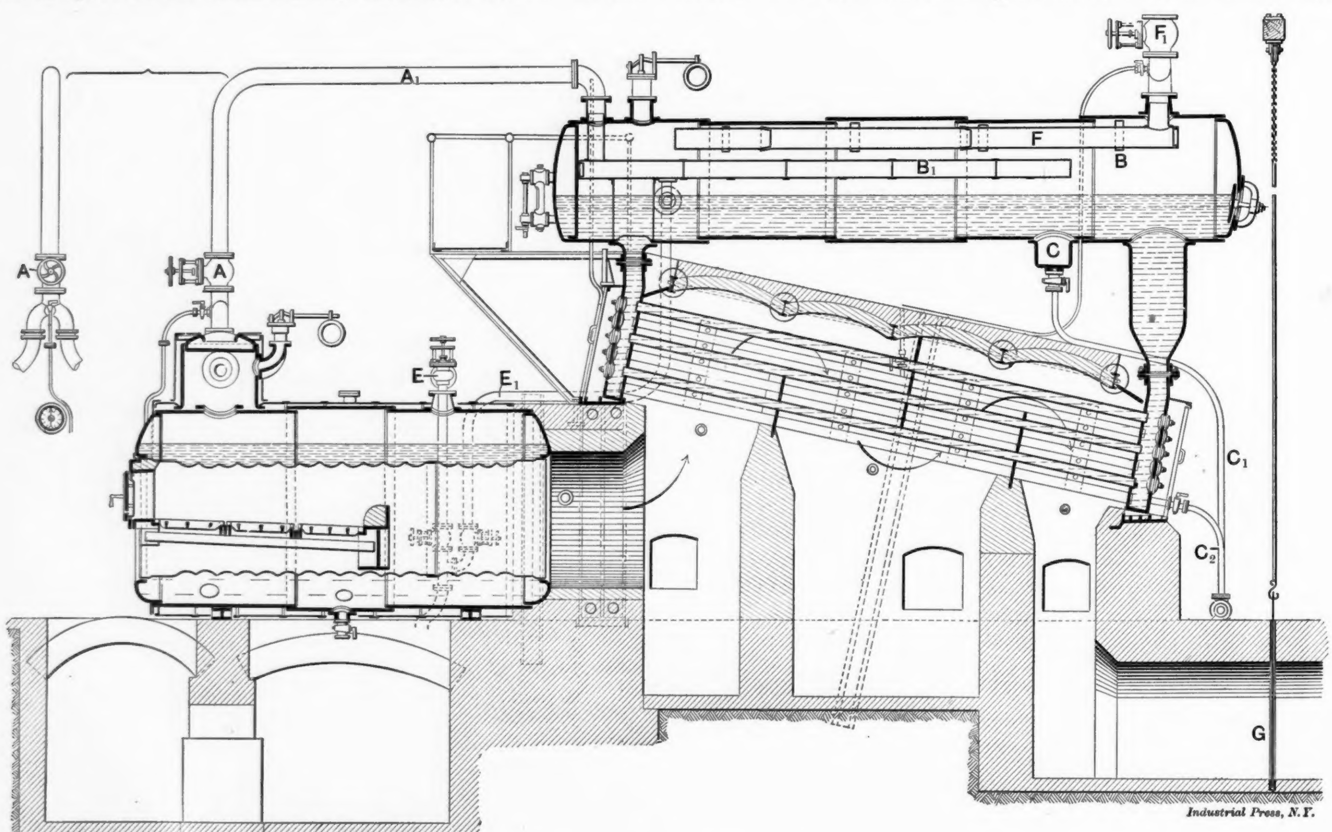


Fig. 2. Longitudinal Section of Boiler.

pipe there is a cut-off cock, *A*. The steam generated in the flue boiler passes out through the pipe A_1 into a steam pipe B_1, placed inside the steam drum *B*, where it parts with the greater portion of its entrained water so that it escapes into the steam space practically in the condition of dry saturated steam.

The grates are the same in both boilers and consist of plain flat bars with a total length of about 6 feet 8 inches, with their front ends resting upon the fire plates and the latter upon a steam. The greater portion of this heat is, however, taken up by the water tubes as the hot gases pass over them in a zig-zag course. After leaving the tubes, the gases pass down into a flue *G* in which there is a regulating damper.

In conclusion, attention may be called to the fact that passages are very conveniently arranged in and about the boiler, so that all parts are rendered easy of access for inspection and repairs. G. L. F.

UNIVERSAL HOLE GRINDING AND LAPPING MACHINE.

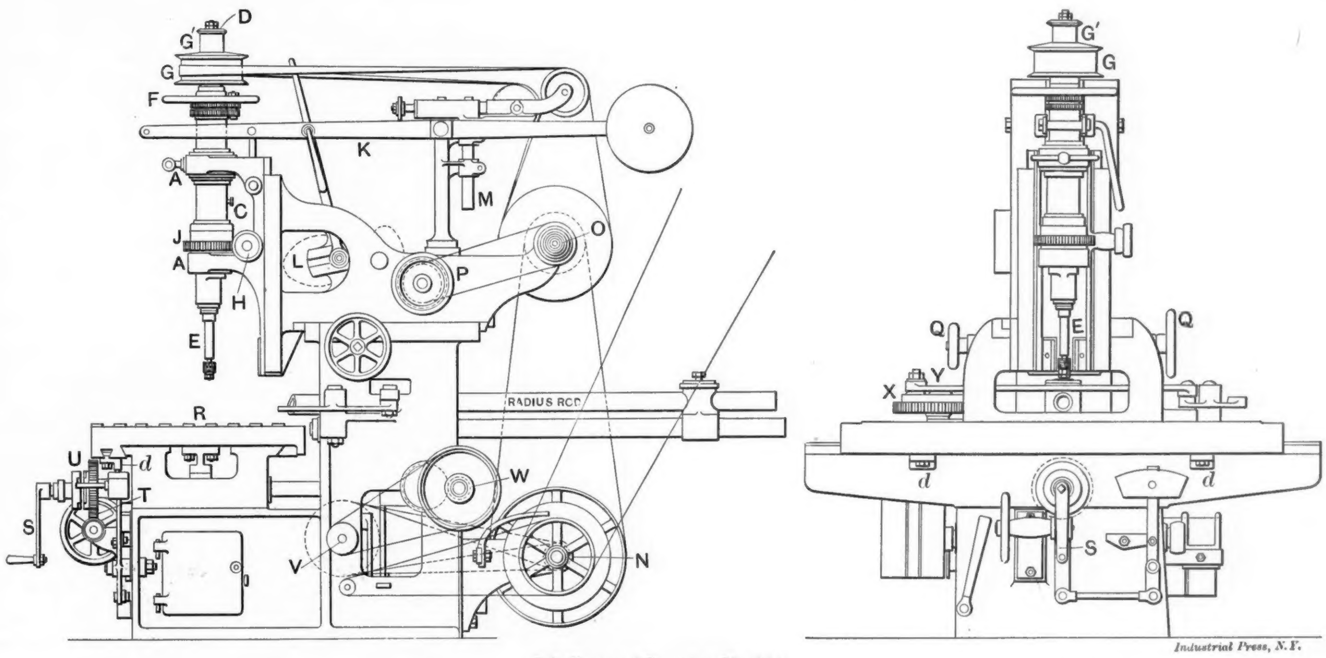
Engineering (London), January 16, 1903, p. 63.

In No. XIII. of the series "Grinding Machines and Processes," Joseph Horner describes a universal hole grinding and lapping machine manufactured by Beyer, Peacock & Co., Manchester, Eng., which Mr. Horner says is quite extensively used in British locomotive shops for grinding links and other locomotive parts. This machine employs the sun-and-planet motion by which the grinding spindle is made to describe a circle as it grinds the interior of a hole, or the exterior of a circular piece. Provision is made for varying the diameter of the circle thus described to accommodate varying diameters. The principle was patented by the firm in 1887.

Provision is made for adjusting the height of the tightener pulleys used for belt or cord by carrying their bearings on a pin *M*, which can be raised or lowered, and clamped in its socket. The reason for this is that the machine shown in this figure has two pulleys, *G* and *G'*, for slower and quicker driving, and the adjustment of *M* is made to suit the lower or upper positions of the belt.

The correct position is found by inserting the emery-wheel in the hole and revolving the main spindle *B*, at the same time throwing the internal spindle *D* sufficiently out of center to bring its emery wheel in contact with the sides of the hole all round. This feed must be effected cautiously, or the spindle may become bent. The vertical reciprocating motion of the emery wheel is either self-acting through the slotted plate *L*, or, by unclamping the connecting-rod, the lever *K* may be operated by hand. This motion should be so adjusted that the lower edge of the emery wheel will travel in the downstroke about ⅜ inch below the bottom of the hole which is being ground, and the top edge about the same distance above the top of the hole on the up-stroke.

For grinding expansion links and blocks the emery-wheel spindle is set concentrically with the main spindle, and is locked in that position by means of a setscrew *C*, the mandrel used for lapping holes being replaced by one having an adjustable lower bearing. The main table *R* remaining stationary, the supplementary table is reciprocated by means of the elliptical wheels and levers *X*, a clutch on the back shaft *W*



Grinding and Lapping Machine.

The countershaft *N* is carried on brackets at the rear of the machine, below. It is speeded at not less than 340 revolutions per minute. The speeding-up to the spindle takes place through an intermediate shaft, *O*, carried at the rear of the headstock. From *O* the worm *H* is belted, and also the feed cones *P*, whence the elliptical feed wheels are driven. The head has a transverse motion on the upright, sliding on *V* edges, and adjusted by the hand-wheels *Q Q*. The main table *R* is slid longitudinally by rack and pinion, actuated by the handle *S*, or, slowly through the worm and wheel *T*, put into gear by means of the clutch *U*. By means of these two movements exact adjustments are made between the grinding spindle and the work on the table.

From the countershaft *N* a shaft *V* is driven with open and crossed belts, whence a drive goes to a back shaft, *W*. From this a pair of bevel wheels drives a pair of elliptical gears, seen partly at *X*. These, being driven and reversed by the action of the open and crossed belts, impart a reciprocating movement to a supplementary table by the lever *Y*, adjusted in a slot disk on one of the elliptical wheels.

In operating one of these machines, the required degree of eccentricity is imparted to the emery-wheel by the hand-wheel, *F*.* The eccentric orbit in which the emery-wheel revolves is then adjusted centrally with the hole that is to be ground by means of the transverse adjustment on the headstock, by the hand-wheels *Q Q*, and the longitudinal adjustment of the main table *R* by the handle *S*, or by the fine adjustment through the worm and wheel *T*, put into action by the clutch *U*, of the machine being put into gear for driving this gear. In grinding straight links and blocks, the supplementary table is guided between V strips which fit into the grooves of the main table. But in grinding radial links and blocks, these strips are removed, and the table is bolted to the radius arm, which must be set to the exact radius required.

* For the principle of this adjustment see February MACHINERY, p. 313.

THE BANKI MOTOR.

Sibley Journal of Engineering, April 1, 1903, p. 265.

MACHINERY has previously referred to the Banki internal combustion motor as invented and developed by Prof. Banki, of Austria. It is well known that in such a motor high initial compression is conducive to high economy, this being the feature that has led to such good results from the Diesel motor. With many mixtures ,however, such as the vapor of benzine and air, natural gas and air, etc., high compression is not possible without resorting to some special expedient, since the heat of compression would be so great as to cause premature explosion in the engine cylinder. Prof. Banki's plan is to obtain the highest practicable compression pressure and at the same time have the fuel mixed with the air required for combustion. With this object in view a fine spray of water is introduced at the same time that the liquid fuel is being sprayed into the cylinder. Both the oil and the water are finely atomized and enter in the form of a spray or mist. During admission and compression the heat transmitted from the cylinder walls and that due to the compression is absorbed in converting the liquid fuel and the water into vapor. The heat required for vaporization is sufficient to keep the mixture at a low enough temperature to pre-

vent premature ignition, and the fuel and water are so proportioned to the load on the engine that ignition will not occur until the end of the stroke. Even then the temperature of the charge is not sufficient to cause ignition and this is consequently provided for by a hot tube in accordance with the prevailing European practice. The engine operates on the common Otto cycle, and governs by cutting out explosions and holding the exhaust valve open on idle strokes. The fuel used is gas, benzine, light gasoline or alcohol.

The principal results of a series of tests on a 20 horse power motor under varying loads are given in the accompanying table. It was not possible to obtain the indicated horse power with any degree of accuracy from the indicator card and so this was computed as closely as possible from the brake horse power tests.

	I	II	III	IV
R. P. M.	209.13	209.67	209.83	210.5
Explosions per minute	91.44	74.68	60.12	42.65
Mean temperature of exhaust, F°.	383.9	384.	366.4	340.
Compression pressure, pounds per sq. in.	235.	235.	235.	235.
Max. pressure of explosion, lbs. per sq. in	641	626.5	598.	556.
Brake load H. P. (French)	26.38	20.7	15.05	8.21
Benzine per B. H. P. hour, lbs.	.489	.519	.576	.72
Injected water per B. H. P. hour, lbs	2.36	1 71	1.63	1.68
Ratio of injected water to benzine by weight.	4.84	3.30	2.82	2.33
Calorific value (lower) of the benzine, B. T. U. per lb.	18,300	18 300	18,300	18,300
Heat used per B. H. P. hour, B. T. U	8,950	9,500	10,550	13.190
Lost in jacket, per cent.	21.35	26.2	23.	27.
Equivalent of useful work, B. T. U.	2,505	2,505	2 505	2,505
Efficiency based on B. H. P., per cent.	28	26.4	23.8	19.
Efficiency based on computed I. H. P., per cent.	35	34.6	32.9	....
Loss in radiation, exhaust and friction work, per cent.	50.65	47.4	53.2	54

There are few, if any, reliable records of gas engine tests which have given efficiencies based on brake horse power as high as those obtained with the Banki motor. Compared with the ordinary type of gasoline or kerosene engines of the same size the efficiency is about double. It is interesting to note the relation of efficiencies of ordinary gas engines when working at compression pressures of 70 and 235 pounds above atmosphere, the former being a value commonly used and the latter that of the Banki engine. The efficiency computed theoretically is about 39.8 per cent. for the former and 56 per cent. for the latter—a relative increase of about 40 per cent. for the higher compression. If, now, instead of taking the theoretical values we use actual efficiencies as determined by test, we have 20 per cent. for the former engine and 28 per cent. for the latter—the same relative increase viz., 40 per cent. This indicates that the introduction of the water does not modify the efficiency, or in other words that the latter is independent of the nature of the working fluid.

BABCOCK & WILCOX BOILERS IN THE MARIETTA.

Journal of the American Society of Naval Engineering, February, 1903. p. 59.

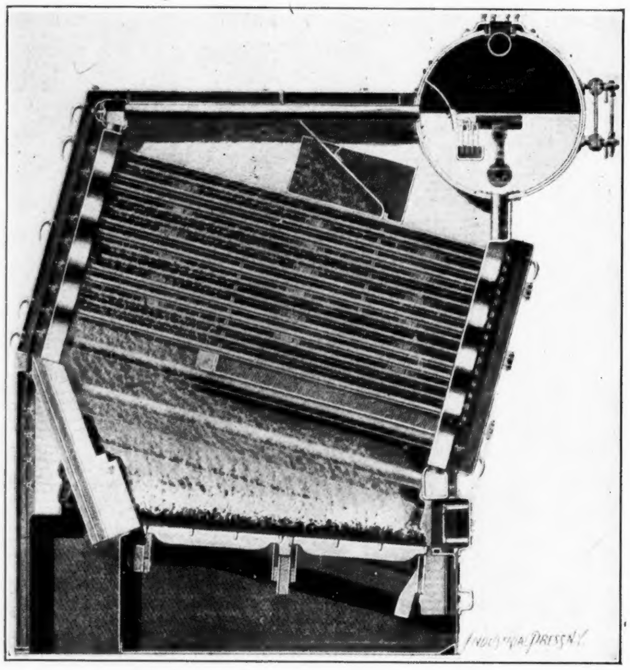
The *Marietta* was put in commission in the United States Navy in September, 1897, and has been in active service ever since. During this period she made the voyage from the Pacific Coast to Santiago, Cuba, to join the naval force of Admiral Sampson. It was only because the country was more concerned in the fate of the *Oregon* that the brilliant service of the gunboat was overshadowed by the work of the battleship and thus the feat of the *Marietta* in reaching the blockading line in practically perfect fighting trim never received the recognition that should have been accorded the smaller of the two vessels that came from the Pacific to battle with Cervera's fleet.

The *Marietta* was fitted with two Babcock and Wilcox Marine type water tube boilers six years ago, which have been in continuous service ever since. During the past five years the *Marietta* has steamed over 80,000 knots, and the boilers have acted so well that it has been very seldom that assistance outside of the ship's force has been required to make repairs. At the present time the boilers are in good condition and everything about them is working well.

The article from which this abstract is made gives a general account of the repairs on the boilers, of their operation, efficiency, etc. About $2\frac{1}{4}$ pounds of coal per horse power were required for general purposes, including steam used for main engines and all auxiliaries. The grate area is 94 square feet, heating surface 3,664 square feet, and the pounds of coal burned per square foot of grate area, 21.75. The following summary of the advantages and defects of the boilers, as found through their use on the *Marietta*, is given:

(a) *Simplicity.*—In regarding simplicity as a primary salient feature of the boiler, it should be understood that there should be, first of all, simplicity of design. Any steam generator which possesses attachments whose operation is not thoroughly understood nor completely under the control of a water tender who has not absolute confidence in their working, is certain to give trouble and prove inefficient for sustained sea work. Then there should be simplicity of construction. Finally there must be simplicity of operation, for that boiler will soon burn out which practically requires the undivided attention of one skilled man simply to look out that a safe water level is preserved.

(b) *Dryness of steam.*—Dry steam has been furnished the engines under all manner of trying conditions. Both muddy and salt water have been used for considerable intervals, and a high gage of water has been carried in emergencies, especially when getting under way, without producing serious results or causing priming.



Babcock & Wilcox Boilers used in the Marietta.

(c) *Reliable feed maintained.*—A steady and reliable feed can always be maintained. It does not require a specially trained or highly paid water tender to look out for things in the fire room.

(d) *Simple tubes used.*—The tubes are of simple, straight lengths, care being taken to use the highest quality of material in their manufacture. Any attachment to a boiler tube invites trouble if it does not make it dangerous. As the tubes are straight they are very accessible for examination. Each tube can be moved independently of the others, and renewal can be made with ease by the ordinary ship's mechanics using simple tools.

(e) *Rapidity of raising steam.*—Steam can be raised quickly and fires suddenly hauled without subjecting the boiler to undue strain. The fires can also be rapidly forced without any ill effect to the working parts.

(f) *Superior materials used.*—All the material used in construction is of superior quality. As an example, one of the feed water heater tubes was reduced by being burned to a thickness of 34 B.W.G. in one place, and yet this tube resisted a pressure of 200 pounds per square inch from the interior.

(g) *Its economic efficiency.*—The efficiency of the boiler will compare with that of any other marine water-tube steam generator. Under forced-draft conditions, also, its economic efficiency will compare favorably with any straight-tube boiler.

(h) *Efficient circulation.*—The circulation of the water is natural and direct, and is not affected by the roll or pitch of the vessel. The endurance of the boilers of the *Marietta* ought to afford direct evidence as to the circulation of the water within the tubes. As the tubes are of large size, there is a continuous and reliable flow of water through them. The arrangement of the elements is such that the expansion of any one tube is uniform. As provision has been made for the proper expansion of the several elements, a leaky tube or joint is of very rare occurrence.

(i) *Accessibility for repair and examination.*—Practically all the vital parts are accessible for repair and examination. The cost of upkeep is comparatively small. With the exception of the headers, all the parts are procurable from many engineering supply establishments.

Summary of Defects.

(a) *Baffling should be improved.*—The liability of the baffling to burn out, and the disadvantage if not the danger resulting from the excessive accumulation of soot upon these baffle plates, has necessitated much annoying work, besides a great loss in efficiency. The removal of the lower baffle plates cannot be done without cutting out some of the tubes.

(b) *The feed-water heater an incumbrance.*—By reason of the manner in which the feed-water heater is installed the rapid corrosion of tubes cannot be prevented, and some are also liable to burn out. This heater is also very inaccessible for repairs and examination. It is not an integral part of the boiler, but simply an auxiliary that was placed in the uptake in order to increase the efficiency of the boiler.

(c) *Arrangement of grate bars.*—The inclination of the grate bars practically renders the back end of the furnace useless for burning coal, because ashes will accumulate there on account of the difficulty of the firemen cleaning that portion of the grate so far removed from the furnace door. The details of furnace design are neither conducive to efficiency nor to good firing. The inclination of the grate makes stoking difficult and laborious. The combustion chamber is too small. The location of the baffle plates draws the product of combustion to the front of the furnace, thus making it almost impossible to clean the back portions of the grate bars.

(d) *Design of casing.*—Various portions of the casing are too light for the purpose intended. Some parts are almost inaccessible for examination, cleaning and repair. The outboard casing of each boiler comes within a few inches of the bunker bulkhead, and thus the condition of these side casings is difficult to note. By reason of the ashpit doors and the front casing not being tight, but little forced draft pressure can be carried, and when it is used the casing and uptake soon become red-hot. By reason of the leakage of this front casing the cleaning of soot from the tubes cannot be efficiently done.

(e) *Location of steam drum.*—The steam drum is attached to the back of the boiler and this arrangement makes it extremely difficult for the water tenders and firemen to reach the valves that should be within easy access of repair and operation. Whenever men have to operate appliances at great discomfort and inconvenience, it is certain that such attachments will not receive the attention they should and it is even inviting danger to install appliances in such a manner.

(f) *Arrangement of caps.*—As the caps over the 4-inch tubes are so arranged that the pressure in the boiler tends to impair the joint, small leaks frequently occur from careless fitting of the plugs. It therefore requires skilled and intelligent men to fit the plugs.

In considering the defects of the *Marietta's* installation, it should be remembered that the boilers of that vessel were designed over seven years ago. Since that time progressive improvement has been effected in the details of construction of the marine boiler of the Babcock & Wilcox design.

As the installation of this type of boiler in the battleships and armored cruisers now under course of construction will permit more height to be secured than was possible on the *Marietta*, a higher efficiency and increased endurance will be secured from the later design.

THE USE OF REHEATERS IN COMPOUND ENGINES.

Paper read before the April meeting of the N. E. Cotton Manufacturers' Association by George H. Barrus.

The object of a reheater in connection with a compound engine is to reduce the loss occasioned by cylinder condensation. If we compute from an indicator diagram the amount of steam present in the cylinder during certain portions of the stroke, and compare the results with the actual amount of steam admitted to the cylinder from the boiler as determined by a feed water test, a considerable discrepancy will be found. The steam computed from the diagram will always be the less of the two. This shortage in weight is caused primarily by cylinder condensation due to the cooling action which at all times accompanies the operation of a steam engine. The condensation varies in different engines and under different conditions, is seldom less than 20 per cent. and is often as much as 50 per cent. In compound engines the loss occurs in both high- and low-pressure cylinders, but it is generally greater in the low-pressure than the high-pressure cylinder. The extent of the loss and its distribution can best be exhibited by summarizing the results of a number of tests made by the writer on fairly tight Corliss compound engines. The losses were computed from points on the diagrams a little later than cut-off and are expressed in percentages of the actual consumption of feed water. The percentages for the high-pressure cylinder range from 21.1 per cent. to 28.3 per cent. and those for the low-pressure cylinder from 23.7 per cent. to 40 per cent.; the averages, in the instances cited, being respectively 23.8 per cent. and 31.4 per cent.

The reheater is placed in the path of the exhaust pipe of the high-pressure cylinder and as its name indicates it reheats the steam passing through that pipe before it enters the low-pressure cylinder and thereby reduces the condensation in that cylinder. In construction, it consists merely of a shell through which the exhaust steam flows, and is provided with live steam pipes or coils supplied from the boilers, and upon these it depends for its source of heat.

In view of the fact that the loss from condensation is noticeably greater in the low-pressure cylinder than in the high-pressure cylinder, there seems to be good ground for employing special means, such as the reheater furnishes for improving the action in this part of the engine.

The principle of the reheater is the re-evaporation of the water and moisture contained in the exhaust steam discharged from the high-pressure cylinder, and further, in cases where the extent of reheating surface is sufficient, the superheating of the whole quantity exhausted. The effect of this is to increase the quantity, volume, and dryness of the steam supplied to the low-pressure cylinder, and the result is two-fold; first, an increase in the relative amount of power developed by this cylinder on account of the new supply of steam produced; and second, the use of the steam with increased efficiency, owing to the saving of cylinder condensation.

Mr. Barrus then goes on to quote from three engine tests, made respectively on a Greene engine, with cylinders 26 and 50 by 60 inches; a Corliss engine with cylinders 18 and 40 by 48 inches; and a Corliss engine with steam-jacketed cylinders having diameters 16 and 40 by 48 inches.

In the first case the tests show a substantial agreement between the total quantity of feed water consumed per indicated horse power per hour, whether the heater was on or off. In other words, so far as the question of economy was concerned, no advantage was produced by the reheater. This result occurred notwithstanding the fact that the reheater caused a marked improvement in the action of the steam in the cylinders. It appears that the reheater did actually re-

duce the condensation in the low-pressure cylinder, thus securing at this point the expected gain. When it was in use the condensation here was 4.4 per cent. greater than in the high-pressure cylinder. When the reheater was not in use the difference was 10.6 per cent. Although there was a saving within the cylinder, nevertheless the loss in steam due to that condensed in the reheating pipes to accomplish this result was so great that the net economy was reduced to zero.

The effect of the reheater upon the power developed by the low-pressure cylinder is most noticeable. With practically the same power in the high-pressure cylinder in the two cases, that developed in the low-pressure cylinder was 35.5 horse power less when the reheater was off than when it was in use.

The results of the second test differed in some particulars from those of the first test, but apart from such variations the important fact was brought out that the total steam consumption was almost exactly the same whether the reheater pipes were in use or out of use, thus bearing out the results of the first test. In the third test again practically the same feed water consumption was found both with and without the heater. Here also were substantially the same reductions of cylinder condensation in the low-pressure cylinder and increase of power in the low-pressure cylinder, but the effects were even more marked. With the reheater in use the condensation in the low-pressure cylinder was 1.2 per cent. less than in the high-pressure, while with the reheater out of use the difference increased to 18.3 per cent. This improvement is a large one, but the advantage was lost when it came to counting in the steam required to supply the coils in the reheater. The steam in the low-pressure cylinder was superheated 38 degrees with the reheater in use, but even this help failed to effect a net gain from the use of the reheater. The effect upon the power was quite as marked as upon the condensation. With the reheater off the low-pressure cylinder developed 40 horse power less than the high-pressure cylinder and with it on 18.7 *more* power than the high-pressure.

The three tests referred to, all show the same action with regard to cylinder condensation. There is a great reduction in the condensation within the low-pressure cylinder, but, owing to the loss of steam in the reheater itself the resulting advantage is practically nothing. That the reheater produces no saving, however, is true only when the steam condensed by the reheating pipes is allowed to go to waste and the heat which it contains is lost. In the first engine there was 4 per cent. of the steam thus condensed; in the second, 8.7 per cent.; and in the third, 10.3 per cent. The temperature of the resulting water, with the high-pressures used, is 340 to 350 degrees Fahrenheit. If we assume now that the temperature of the feed water supplied to the boiler is 125 degrees, each pound of condensed steam thus lost carries away with it over 200 heat units, or, in round numbers, 20 per cent. of the total heat of evaporation. Taking the third engine, this loss represents 20 per cent. of 10.3 per cent., or about 2 per cent. expressed in fuel consumption. Consequently, if the condensed steam from the reheater of this engine were returned to the boiler, there would be a saving of fuel, due to its use, amounting to about 2 per cent. It may be safely concluded, therefore, that, although a reheater produces no saving in steam consumption, it will, if properly applied, secure a slight economy at the coal pile.

Apart from the consideration of fuel economy, there is the important question of the effect of the reheater upon the engine capacity. The tests show, without exception, that with the same power in the high-pressure cylinder, the reheater produces a considerable increase in the power of the low-pressure cylinder, and to that extent it increases the capacity of the entire engine. In the case of the first engine the increase was 4.6 per cent. of the total power. In the second engine the increase was 6.3 per cent., while in the third it was 11.8 per cent. This means that an engine without reheater must have larger cylinders, to do the same work, than an engine with reheater; or, if the cylinders are of the same size, there is more reserve power in the engine which is provided with a reheater. This feature of the subject makes the reheater advantageous even if it produces no other gain.

SURFACE CONDENSER USING MOIST AIR AS THE CONDENSING MEDIUM.

Engineering News, April 2, 1903. p. 305.

Arthur Pennell, Kansas City, Mo., is the inventor of a surface condenser using moist air for the cooling medium without the use of a fan blower to force the air through the condenser tubes. A cylindrical shell similar to a horizontal tubular boiler, 78 inches in diameter, is stood vertically over a cistern. The shell is carried above the upper tube sheet to increase the draft. The tubes are of steel, 4 inches in diameter, and are closely spaced. A centrifugal pump circulates about one-half gallon of water per minute from the cistern below the condenser up over the upper tube plate, where it is so diverted as to flow down equally through each tube and form a film of water on the interior surfaces. The exhaust steam enters at the side of the shell and is caused by baffle plates to circulate among the tubes, condensing as it goes and falling to the bottom of the shell where it is drawn off by a vacuum pump to the hot-well.

The condensing action is as follows: The exhaust steam in the shell heats the tubes and the water film on their internal surface; the latter evaporates, at the expense of the latent heat of the steam, into the air in the tubes, saturating the air at its own temperature. Hot saturated air is much lighter than the normal atmosphere, so an upward current ensues, the hot vapor-laden air rushing up the flue and carrying off the heat into the atmosphere, while fresh air enters from below to replace it and be saturated at a higher temperature in its turn. The film of water on the cooling surface is secured without interference with the ascending air currents and also without the use of sprays through small orifices, likely to become clogged with rust or sediment.

Two condensers of the type above described were erected early in 1898 at No. 3 Power House of the Armour Packing Co., in Kansas City, Mo. Tests of a condenser of this type made in April, 1901, showed the average amount of steam condensed per square foot of cooling surface per hour to be 2,038 pounds. The air entering the condenser had a temperature of 62 deg. and it left at a temperature of 106 deg. The following below gives the principal figures of the test. The condenser took the steam from a 30 × 58 × 48-inch engine running at 45 r. p. m. The trial lasted nine hours and the tabulated data follow:

Average steam pressure at engine by gage....	139.8 pounds
Average vacuum per engine gage..............	18.38 inches
Average vacuum per mercury column........	17.50 inches
Average temperature in condenser..........	123.7 deg. F.
Average temperature of circulating water.....	116.4 deg. F.
Average temperature of city water............	52 deg. F.
Average temperature of outside air...........	62 deg. F.
Average temperature saturated air, condenser	106 deg. F.
Average draft in stack of condenser........	1-10-inch
Average humidity of outside air.............	67 per cent.
Total amount of steam condensed............	71,550 pounds
Average amount of steam condensed per min..	132.5 "
Average amount of steam condensed per hour	7,950 "
Total amount of circulating water used......	1,032,060 "
Average amount used per minute............	1,911.22 "
Total amount of city water used..............	31,150 "
Average amount used per minute............	57.7 "
Ratio of circulating water & steam condensed	1 to 14.42
Ratio of city water and steam condensed......	1 to 0.435
Average horse power of engine during trial, per indicator cards	569.74
Average hourly weight of steam used, per I.H.P.	13.95 pounds
Average horse power required to run air pumps	10½ H. P.
Average horse power to run circulating pump	3 H. P.
Total amount of condensing surface..........	3,900 square feet
Amount of steam condensed per. sq. ft. surface, per hour	2.038 pounds

* * *

An attempt to fix the velocity of light with greater accuracy, using the toothed-wheel method of Fizeau under improved conditions, has been described by M. Perotin. In previous experiments, the beam of light, was made to travel a distance of 12 kilometers (7.452 miles) and back, but in the recent trials it was reflected from a mirror placed at a distance of 46 kilometers (28.566 miles) from its source. From 1,109 observations the velocity has been found to be 299,880 kilometers (about 186,225.5 miles) per second, with a probable error less than 50 kilometers.

RESULTS OF TESTS ON HIGH-SPEED ENGINE.

A test was recently conducted at the Worcester Polytechnic Institute for the Buffalo Forge Co. upon one of their horizontal high speed engines having cylinders 12 by 12 inches and scheduled to run at 300 revolutions a minute. Profs. Sidney A. Reeve and C. M. Allen conducted the test, and the results are a fair criterion of what may be expected from a well-designed single-valve engine of this type under good conditions.

The engine was erected upon temporary foundations on the power house floor and belted to a quill upon the main line shaft. Steam was drawn from the vertical boilers through 36 feet of permanent covered pipe and 17 feet of temporary naked piping. The exhaust was led through three elbows and 14 feet of pipe into a surface condenser with which all other connections were broken. During the tests the quality of the steam, as determined by the calorimeter, was practically dry and saturated. The condition of the steam supplied to the engine was frequently investigated.

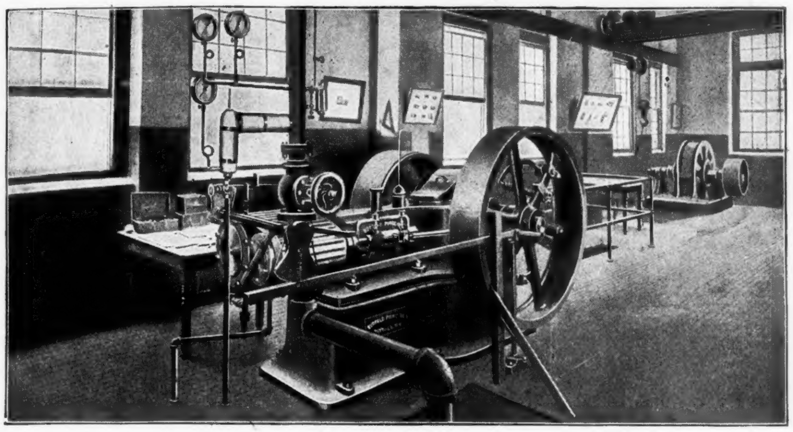


Fig. 1. Engine in Laboratory of Worcester Polytechnic Institute.

In order to insure absolute steadiness of power developed, the engine's governor was blocked into such positions as would give the various cut-offs desired. The speed was maintained constant by insuring that the load was at all times greater than that which the engine would drive, the balance being made up by a second engine belted to the same line shaft. The governor of this second engine performed the regulation for the entire system. The speeds recorded are therefore no record of the action of the governor of the engine under test. During any one test the speed was sensibly constant.

TABLE OF RESULTS.

Condition of Engine.	Gage Pressure.	Revolutions per min.	Power	Water Rate.	Cylinder Efficiency.	Thermo. Efficiency.
Normal cut-off, 125 lbs.	124.75	312.1	123.5	27.5	55.8%	9.16%
Normal cut-off, 80 lbs.	79.96	301.8	71 55	31.3	59.2%	8.12%
25% under load, 80 lbs.	79.85	297.7	56.18	33.1	56.0%	7.68%
50% under load, 80 lbs.	81.90	304.6	37.09	35.4	51.9%	7.19%
75% under load, 80 lbs.	81.50	306.3	16.65	51.1	36.1%	4.98%
25% over load, 80 lbs.	80.57	301 3	87.00	34.0	54.4%	7.49%
Normal cut-off, condensing.	80.95	311.3	87.64	27.7	66.8%	9 21%

The weight of the steam consumed for all of the tests was determined by condensing the exhaust, care being taken, when making the "non-condensing" tests to have the pressure in the condenser exactly at the pressure of the atmosphere, at the same time allowing no vapor to escape. During the "condensing" tests the vacuum maintained in the condenser—about 22 inches—was the best that could be in view of the limited size of the condenser.

This arrangement left the steam pressure as the only variable in any one test and this was kept as nearly constant as possible. The duration of each test was twenty minutes, but the engine was always kept in continuous operation for at least one hour before entrance upon a test.

The indicator readings were taken from a pair of Thompson instruments and the indicator rig was built especially for the tests. It contained no geometric error; the error from lost motion was imperceptible; the length of cord involved was eight inches for one indicator and 24 inches for the other. The indicator cocks were screwed directly into the cylinder ports. All gages and thermometers were calibrated.

The friction of the engine was also determined, when running empty. Because of the difficulty of making this determination with reliability, two different indicators and six sets of springs were employed. The result of the whole is that the engine's friction is estimated at very close to 3 horse power or 4.3 per cent. of the engine's rating. The unusual lightness of this friction led to the repeated checking of its observation, as just noted, before accepting the result.

The results of the tests are given in the accompanying table. The only explanation needed is perhaps with regard to the column of "cylinder efficiency." These figures show the proportion of the heat available for work under the conditions actually prevailing at the time of the test which the engine succeeded in converting into work. That is, it is the percentage of the theoretically possible which the engine actually attained. In this column 100 per cent. would be the record, not of an engine which converted all of its heat supply into work, for no engine could imaginably do that, but of an ideally perfect engine operating under the conditions under which the Buffalo Forge Company's engine operated. The results figured in this way prove to be good standard ones.

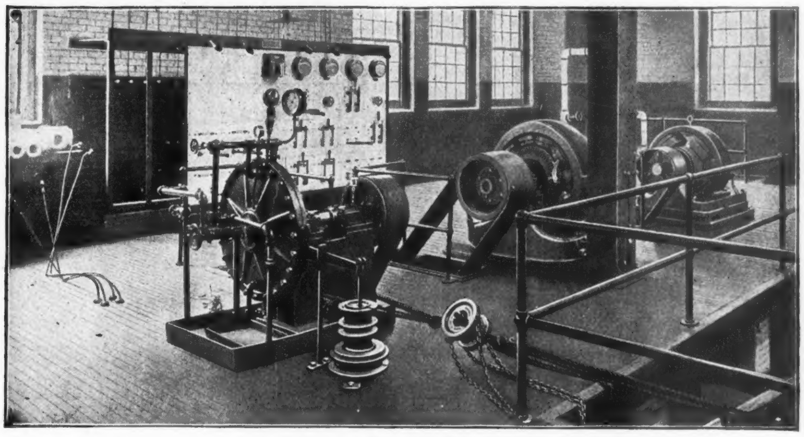


Fig. 2. Alden Absorption Dynamometer used in Conducting the Engine Tests.

In addition to the efficiency tests, was run a 36-hour endurance test under 80 pounds of steam pressure and a load of 69.67 horse power. During its imposition two observations of efficiency were made and their results are scheduled with the others. As to the showing made by the engine under this endurance test, it can only be said that no fault or suggestion of fault developed. The engine ran smoothly and quietly, with cool bearings, throughout the test. When shut down it was apparently ready to start upon a second similar run with equal success.

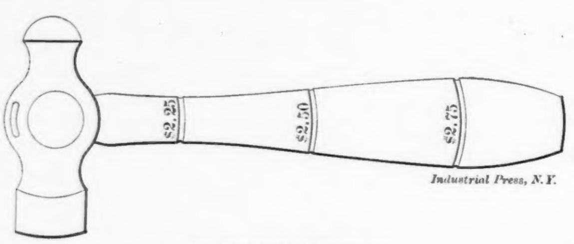
As to the general design and construction of the engine, regarding which an inquiry was made by the builders when the tests were arranged for, Profs. Reeve and Allen report that with all that could be seen upon dismembering the engine, both before and after the series of tests was run, they were very favorably impressed. For simplicity, compactness, good distribution of metal, and convenient arrangement, it provoked favorable comment from all who saw it.

LETTERS UPON PRACTICAL SUBJECTS.

THE GRADUATED HAMMER.

Editor MACHINERY:

While employed in a small shop, in the suburbs of Chicago, I witnessed what was to me a very amusing incident. A new man was put to work on the bench beside me who proved to be a wandering machinist who had worked all over the country—a "journeyman for further orders" as it were. He had been in the shop three or four days when the foreman chanced his way and wishing to borrow a hammer he asked Mr. Wanderer for the loan of his. On picking it up he started to examine the handle which certainly presented an odd appearance, as it had been graduated with knife cuts in the manner shown in the sketch. Being somewhat curious I listened attentively and was enlightened by the following conversation:



The Graduated Hammer.

Foreman—"What the —— are all the marks and numbers cut in this handle for?"

Wanderer—"So's I can tell where to take hold of it."

F.—"That explanation is about as clear as mud."

W.—"The next time I am doing a little chipping just watch me."

A little later—Enter the foreman, glancing with a puzzled look at the Wanderer who is busily engaged chipping.

Foreman—"Well, I see you are holding that hammer near the head. What is that for?"

W.—"For? Why don't you see that this is the $2.25 mark? that's what I'm getting here. Make it $2.50, and I hold it in the middle. Do the handsome thing and give me $2.75 and you will see me hold it at the end."

The foreman walked away laughing. But that night when the Wanderer received his pay envelope it contained a card saying that in the future his pay would be $2.75 per day.

R. A. LACHMANN.

Chicago, Ill.

THE STRENGTH OF CONCRETE.

Editor MACHINERY:

The writer recently assisted at a series of tests of a number of small concrete arches and the results of these experiments give a good idea of the strength of concrete and may prove of interest to some of the readers of MACHINERY. These arches were of 18 inch span, having a rise of 7 inches and were 6 inches wide and 6 inches thick at the crown. No rods, wires, or other means were employed to give the concrete extra strength. The ends of the arches were suitably supported so as to obtain the same result as if they had been made between two I-beams in a building. A concentrated load was applied to the crown of each arch.

The poorest arch, made of 1 part Portland cement, 2 parts sand, and 5 parts ¾-inch broken stone, stood an ultimate load of 13,200 pounds. This was a poorly constructed arch, having been rammed very little and the ingredients not well mixed. Arches composed of 1 part Portland cement, 2 parts sand, and 4 of ¾-inch broken stone, stood ultimate loads of from 14,000 to 26,000 pounds.

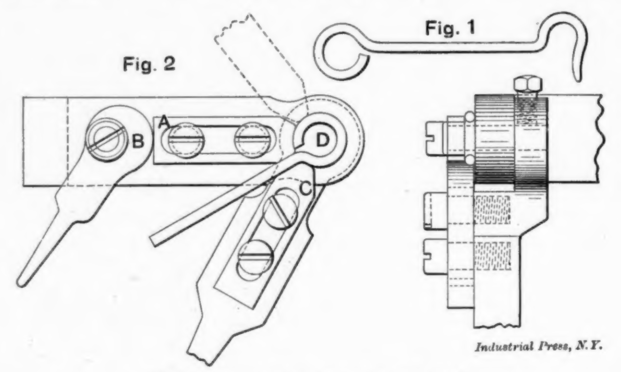
We also made a small block of concrete (proportions 1, 2, and 5) which was simply placed in a mold. After a period of thirty days, a pressure of 637 pounds per square inch was required to crush it. Another interesting experiment was that of imbedding a twisted wrought-iron rod, of ¼-inch square section, in 12 inches of concrete. After becoming thoroughly set, a pull of 1,450 pounds was required to loosen the rod.

New York City. CHAS. G. PEKER.

FIXTURES FOR FORMING WIRE HOOK.

Editor MACHINERY:

The article on wire bending, by C. D. King in the December number of MACHINERY, calls to mind a device used in a wire shop for forming hooks such as are shown in Fig. 1. The first part of the forming operation is performed in a fixture similar to that described by Mr. King except that the sliding lever *A*, Fig. 2, is substituted for the pins that hold the wire while it is being bent. The screws allow this finger to slide freely back and forth when operated by the cam *B*. The end of the finger is beveled at the proper angle to bend the wire



First Operation for Forming the Hook.

radially at the end of the stroke of the lever *C*. With this arrangement the wire can be placed in the fixture and the cam *B*, swung down so that the finger binds the wire firmly against the pin *D*. The lever *C* is then swung from the dotted position to that shown by the full lines, when the eye is completed, thereby saving the second operation that is necessary with Mr. King's fixture.

The hook is then bent on the other end by means of the fixture shown in Fig. 3. To the base *A* is fastened the former *B*, having a clamping finger *C* that is operated by the cam *D*, similar to the cam and finger used for the first operation. The lever *E*, to which is fastened the finger *F*, is pivoted beneath

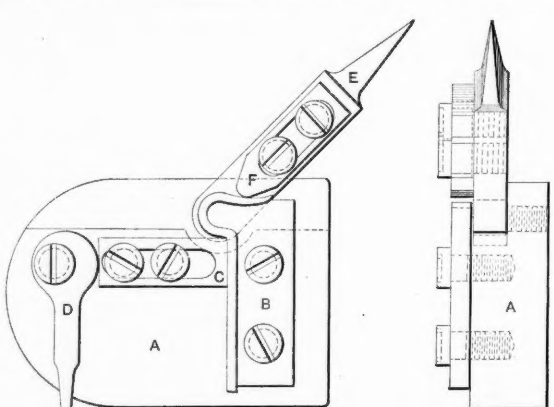


Fig. 3

Second Operation for Forming the Hook.

the former *B*. Finger *C* should slide freely on the screws but *F* should be fastened securely to the lever *E* so that it cannot slip. The wire is placed in position and the finger *C* is brought forward by the cam *D* thereby producing the first bend; the lever *E* is then thrown over to the position shown in the cut, thus completing the hook. These fixtures do very well for a small quantity of such work, but, of course, in large shops engaged in the bright wire business such pieces would be produced with automatic machines. NIX.

THE METRIC LEADSCREW.

Editor MACHINERY:

In the conclusion of an interesting article on the metric system (MACHINERY, April, 1903,) Mr. John M. Barnay remarks: "Why, under the circumstances, the foreign buyer should risk the delay and additional expense connected with extras, such as furnishing metric screws, does not seem

clear." The "circumstances" spoken of are that it is possible, by the simple addition of a translating gear, to convert the "inch measurement" screw into a metric one, and his letter explains how this can be accomplished. Having given a great deal of study to the subject of screw cutting, both theoretical and practical, I must certainly differ with Mr. Barnay and hope to be able to show why the screw cutting lathe must of necessity be fitted with a screw whose pitch can be expressed in the system of the pitch of the work. I use the word "necessity" advisedly.

Present-day competition, in the engineering trades especially, demands that work be accomplished with the least resistance possible. I am aware that in screw cutting practice the backing belt is often used to return the carriage to its starting point, but would any workman if cutting a long screw, of the same pitch, or a multiple of the pitch of the leadscrew, attempt to do the work in this manner? Personally, even for the shorter lengths of screws, I am not in favor of backing by belt and believe it is beyond dispute that loss of time must be entailed by so doing. In certain cases of exceedingly coarse or odd pitches, no doubt, unless the workman be skilled in catching the thread the backing belt is much handier than the English method of chalking—running back by hand and meshing again when the chalk marks coincide—but for all ordinary methods of work, the chalking method is the only one that economy of time will permit.

Now if a lathe be fitted as mentioned by your correspondent, back belting would be absolutely imperative with the result that on all simple work much time would be lost. As the translating gear has 127 teeth it will be necessary to allow the spindle to make at least 127 turns before the toolpoint would coincide with the thread being cut—if we disengage the nut—and in some cases two, three, or more times 127 turns, depending upon the pitch in millimeters being cut. Hence the backing belt must be used for every possible pitch in millimeters no matter how long the work, it being quite apparent that to run through so many idle turns could not be permitted.

Francis W. Shaw.

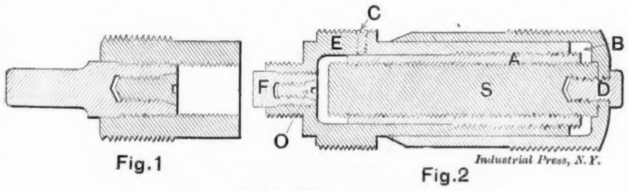
Birmingham, England.

AN INSIDE MICROMETER.

Editor Machinery:

In the December, 1901, number of Machinery, I described a small inside micrometer for measuring holes from 1 inch to 2½ inches. This tool has proved so successful that I have since designed a similar micrometer adapted to measuring, by use of extension rods, from 2 inches up to any size of hole and having one inch adjustment of the measuring screw.

Referring to the section shown in Fig. 2, the measuring screw *S* is secured to the thimble *B* with the screw *D*, the head of which is hardened and forms the anvil. By loosening this screw *D*, the thimble can be rotated to compensate for

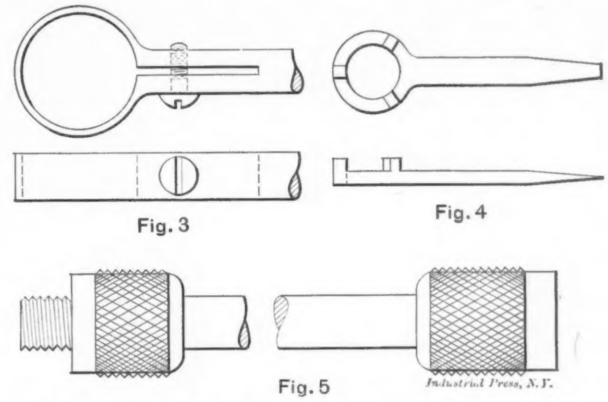


Inside Micrometer.

wear. The wear of the measuring screw and nut is taken up by screwing the bushing *A* into the frame with the wrench shown in Fig. 4. This bushing is split in three sections for about two thirds of its length on the threaded end. The three small lugs on the wrench fit into these slots. The handle end of the wrench is a screw driver which is used for manipulating the set screw *C*. The bushing is made an easy fit in the frame on its plain end and tapered, as shown, on its outside threaded part. This thread being the same pitch as the measuring screw, adjustment for wear does not affect the reading of the micrometer. This manner of adjustment brings the nut squarely down on the measuring screw for its whole length, presenting the same amount of wearing surface after adjustment as when new.

The point *F*, which is hardened on its outer end, screws into the frame and is secured by the taper-headed screw *O*, which screws into and expands the split and threaded end of the point *F*. The handle, Fig. 3, clamps over the knurled part of the frame for use in small, deep holes. The rods, six in number, running from 1 to 6 inches inclusive, are made by screwing a sleeve onto a rod with a hardened point and locking it with a taper-head screw on its threaded and split end, the same as in the point *F*. The extension pieces Fig. 5, are adjustable, on their socketed ends, in the same way, and run in lengths of 6, 12, 18 inches, etc.

Watervliet, N. Y. M. H. Ball.



Wrench and Extension Rods for use with the Inside Micrometer.

MORE ABOUT CUTTING SPIRALS.

Editor Machinery:

In the March issue of Machinery there appeared an article, by Mr. J. T. Giddings, on the subject of cutting spirals on the universal milling machine. While employing the same method, in whole or in part, for the calculation of all ordinary cases, I think that my method in case of fractional or decimal leads is preferable and more accurate than that described. To illustrate, let us consider the same examples that were used by Mr. Giddings.

The first example was to find the change gears for a lead of 1.25 inches to one turn. Then $\frac{1.25}{10}$ is the ratio of the gears, and instead of reducing the expression to the fraction ⅛, multiply both terms by 100 which gives $\frac{125}{1000}$ and resolving this into factors, we have:

$$\frac{125}{1000} = \frac{5}{10} \times \frac{25}{100} = \frac{30}{60} \times \frac{25}{100} = \frac{24}{48} \times \frac{25}{100} = \frac{36}{72} \times \frac{24}{96} = \frac{30}{72} \times \frac{24}{80}$$

which means that gears of 30 and 25 teeth can be used as the two driven gears when gears of 60 and 100 teeth are used as drivers, or any other of the above combinations may be used.

In the second example Mr. Giddings takes a lead of 2.22 inches to one turn and, by finding the gears by his method, does not find those that will give exactly this lead. By the method proposed we have:

$$\frac{222}{1000} = \frac{6 \times 37}{10 \times 100} = \frac{36 \times 37}{60 \times 100} = \frac{24 \times 37}{40 \times 100} = \frac{24 \times 74}{80 \times 100} = \frac{24 \times 37}{80 \times 50}$$

or several other combinations might be used which would give exactly the required lead, the numbers above the line representing the driven gears and the numbers below the line the driving gears. It is more essential to cut a short lead accurately than a long one, since a slight difference in a short lead will change the angle more than a greater difference in a longer lead.

If the lead should be given in thousandths, multiply both terms by 1,000, or what is perhaps more easily remembered, call the required lead a whole number and annex as many ciphers to the 10, in the denominator, as there are decimal places in the required lead. For example: Given a lead of 2.176 inches, the ratio of the gears is $\frac{2176}{10000}$. If the required lead should be given in the form of a fraction that would reduce to a circulating decimal, as 1-3, 1-6, 1-7, etc., it should not be reduced to

a decimal but should be calculated in the following manner. Example: Given a lead of 2 1-3 inches, to find the gears, Then:

$$2\tfrac{1}{3} \div 10 = \frac{7}{3} \times \frac{1}{10} = \frac{70 \times 24}{72 \times 100} = \frac{56 \times 24}{72 \times 80}$$

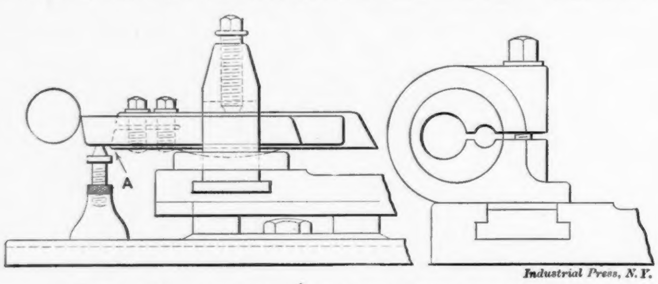
SPIRAL MILLER.

PATENT CUTTING-OFF TOOLS—GRADUATIONS ON THE COMPOUND REST.

Editor MACHINERY:

I was much pleased to read Mr. S. Byron Welcome's article on patent tool holders in a recent number of MACHINERY, as it has always been somewhat of a mystery to me why such an obvious time-saver as the tool holder has not been more generally adopted. In one respect, however, I must differ with Mr. Welcome, and that is in regard to his statement of the failure of the manufacturers to produce a good cutting-off tool. The writer feels sure that the fault is not with the makers but rather with the users (or abusers) of the tool.

As for the off-set cutting-off tool, while it is at times very desirable for cutting off work close to the chuck, it is also necessary that it should be set on the center in order to cut to the center; and to accomplish this it is, in nearly every instance, tilted on the tool post in such a manner that all of



Figs. 1 and 2. Patent Cutting-off and Boring Tool Holders.

the side clearance is on one side, instead of being evenly divided as is necessary to insure the tool clearing itself as it enters the cut. The result is that the blade inevitably breaks and the weakest part of the holder, *A* in Fig. 1, is bent downward. If, however, the blade is supported directly underneath the cutting edge, as shown in the sketch, by means of a small jack, or even an ordinary bolt and nut, the tendency to spring and dig into the work is entirely eliminated. This also prevents disagreeable chatter which generally results when trying to run at a moderately fast cutting speed such as the self-hardening blades are designed for.

There is no necessity for using a quart of lard oil every time a piece of steel is cut off; a small brush dipped in the oil will supply all of the lubrication that is needed. The makers of the patent tools specifically state that they are to be ground on the end only, yet how many mechanics will grind off the top of the blade with the idea of taking off a nice curling chip. When tool holders fall into such hands it is only natural that the whole lot should be condemned as no good.

Of boring tool holders, one of the best that the writer has seen is shown in Fig. 2. The eccentric holes in the bushing not only permit the use of a large or small bar but slight variations in the height of the cutting edge are thus provided for. If it is an advantage to have the bar very stiff, one end may be run in a bushing fitted to the tapered hole in the tailstock spindle.

A few words on the subject of graduations: The base of the compound rest, the cross feed screw and the taper attachment have graduations to facilitate setting, which are very useful when intelligently used. It should, however, be remembered that in using the compound rest, the tool must be set on the center or the bevel turned will not be the one indicated by the graduations on the base of the rest. The same applies to the taper attachment. A man will turn a taper, take his tool out and grind it and then, after replacing it, wonder why the next piece turned has not the same taper as those he has previously done. It never will have the same taper unless the tool is set at the same height and this is a somewhat difficult thing to do with the common tool post. The best method is to take the work out of the centers and set the tool exactly on the center. I have yet to meet the old-fashioned workman with his calipers and scale who could work around the young fellow who uses his micrometers in conjunction with the graduations on the cross feed screw.

New York City. H. J. BACHMAN.

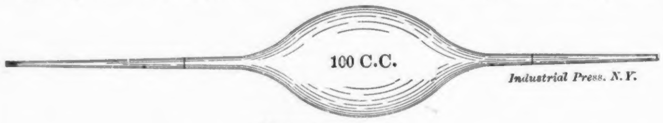
VISCOSITY OF OILS.

Editor MACHINERY:

The design and operation of bearings in machinery rest on the effective action of the lubricant, and failure or success depends not only on mechanical conditions, but on the lubricant chosen. The objects in the use of lubricants are to reduce loss of power by decreasing friction, to minimize the wear of parts, and to prolong the life of the machine. For some years experimenters have recognized that the value of lubricating oil depends upon two important properties, namely, viscosity and body. Professor Thurston early pointed out that the case of perfect lubrication was capable of exact mathematical treatment. In 1886, Professor Reynolds published an elaborate analysis of such a case. In any well fitting journal in which perfect lubrication exists, the friction is determined by the speed, the pressure, and the viscosity of the oil. Varying any one of these factors while keeping the others constant, there is some value of the variable for which the coefficient of friction is a minimum, which at the same time marks very nearly the limit of the variable for perfect lubrication.

The primary requisites of a good oil are that it shall wet the surface of the bearing, for this, in general, gives the lowest friction. It shall not contain free acid, or become decomposed by the metals with which it comes in contact. It shall not contain any volatile matter, or become thickened by oxidation. Viscosity is the property of oil by virtue of which lubricants form a comparatively thick film between the rubbing surfaces. A condition essential to the formation of such films is that the rubbing surfaces have a very slight inclination to each other in the direction of their relative motion. This condition is generally fulfilled by the slight difference in the radii of the journal and the bearing, due to the original looseness of fitting, or to wear. The films formed under such conditions vary from .00021 to .00077 of an inch under loads varying from 27 to 270 pounds per square inch. Since the value of an oil as a lubricant depends upon viscosity to a far greater extent than it does upon body, the following experiment has been devised as a simple means of determining viscosity without regard to body.

One of the simplest and best methods for comparing viscosity is by the use of the viscosity pipette. This method is used by the Pennsylvania railroad for testing their oils, and



Viscosity Pipette.

though it may lack scientific accuracy, it serves to compare readily the viscosity of different oils for all practical purposes. By this method the viscosity is shown as the time in seconds required for a certain volume (usually 100 cubic centimeters) to flow through a standard orifice. This orifice is of such a size as to allow 100 cubic centimeters of water at 100 degrees Fahrenheit to flow through it in 34 seconds. This time is not proportional to viscosity but it gives a means of arranging fluid lubricants in the order of their viscosity. It is obvious that this method is useless for semi-solid and solid lubricants. In order to determine viscosity by this method, the pipette holding 100 cubic centimeters of the fluid is mounted on a lamp stand with the lower end dipping into a cup to catch the oil as it flows from the orifice. The oil tested is drawn up into the pipette, and the time it takes for 100 cubic centimeters to run out is noted. This is called the viscosity of the oil for that particular temperature.

With such an apparatus arranged in the manner described above, the writer made a number of tests on both animal and mineral oils at various temperatures. The results were plotted in curves thus allowing the viscosities of the different oils to be compared at any temperature within the range of

the test. Curves 1, 3 and 5 are results of tests on mineral oils; while curves 2 and 4 are tests on animal oils. From these curves it can readily be seen that the viscosity of all the oils becomes less as the temperature increases. With increase of temperature, the viscosity decreases proportionally faster for those most viscous at the ordinary temperature. The rate of decrease is not the same for all oils. As the temperature rises, the organic or animal oils, in general, show less rapid decrease than the mineral oils. It has been found by other tests that, of oils having the same viscosity at any temperature, the organic oils are ordinarily more oily. In the samples tested the viscosities of the mineral and animal oils approach each other as the temperature rises until, at 240 degrees Fahrenheit, they are very nearly equal.

Therefore, since viscosity is the chief property upon which the value of an oil as a lubricant depends, the above method, while it does not give a scientifically correct result for viscosity, does furnish a simple method for comparing the viscosities of different oils. This, in turn, will determine the value of the oil as a lubricant at the temperature at which it will have to operate in the machine in which it is used. It will thus enable the user to select an oil which will give him the best satisfaction under the conditions which exist in the machinery, in the bearings of which the lubricant is to be used.

ARTHUR W. COLE.

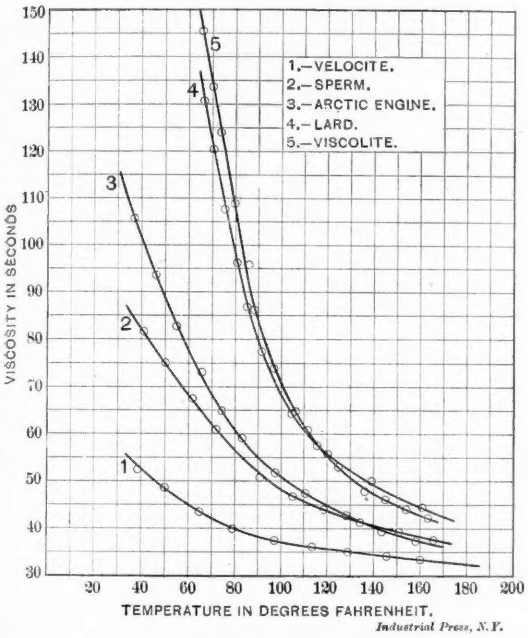
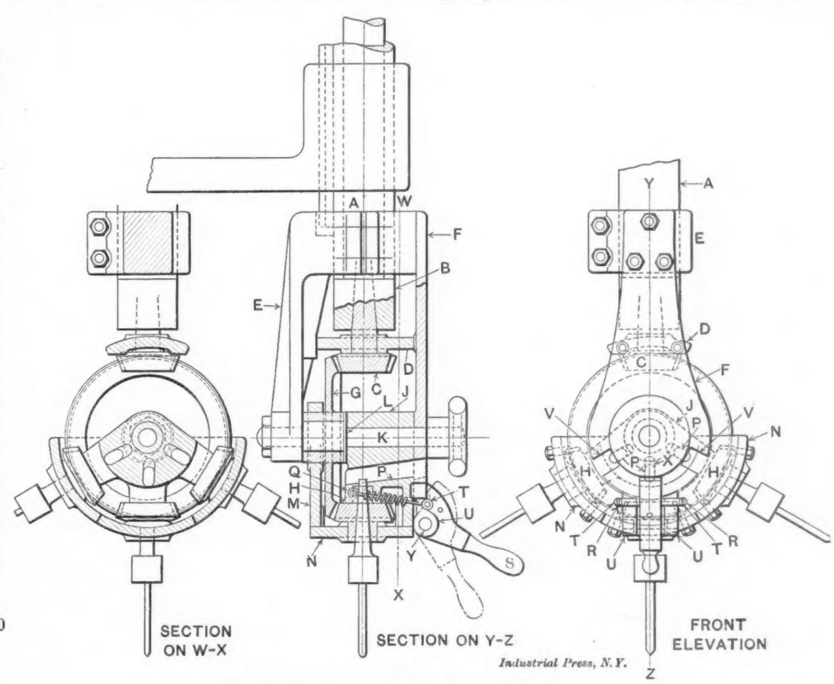


Table showing Relative Viscosity of Oils Tested.



Turret Attachment for use on Drill Press.

TURRET ATTACHMENT FOR THE DRILL PRESS.

Editor MACHINERY:

In handling small jig work the length of time required for putting the piece in and out of the jig is often as great as that required for drilling the hole; or if it is thought advisable to keep the work in the jig from start to finish there is a great loss of time in changing the drills. There are several methods in use for eliminating this loss, such as the use of a chuck with collets which may be changed while the drill is running and also the use of multiple spindle drill presses. The interchangeable collet system is first rate for large drills with taper shanks, as the same collet will fit any drill; but for small work, requiring straight shank drills, it is necessary to have a collet for every size of drill in use or else to have several small chucks fitted with collets and, at best, some time is lost in changing and in selecting the right one.

The multiple spindle drill press is by far the best method if there is a sufficient amount of work to warrant it. There are, however, many cases where but little of this work is to be done and to meet such a case the drill press turret attachment here described was designed. This is attached to any drill press and, as designed, is of course suitable only for light work. It is illustrated in section and elevation in the drawings presented herewith.

Clamped fast to the drill press quill *A*, is the bracket *E* which carries a stud *K*. Running loose on this stud, between its head *L* and the hub of the casting *E*, is a bevel gear *G*, which is driven from the drill press spindle through the pinion *C*, and it in turn drives a series of bevel pinions *H*, *H*, *H*, whose hubs are bored with a taper hole to fit the shank of any small chuck or collet. Free on the stud *K*, is the turret *J*, which has three radial hubs that are bored to form a suitable inside bearing for the hubs of the pinions *H*; the outside bearings of these pinions being formed by the segment *N*, which is bolted on one side to a semi-circular flange of the turret *J* and on the other to a semi-circular plate *M*, running free on the hub of the gear *G*. This combination makes an extremely long and rigid bearing for the turret and is also an easy piece to manufacture as it is possible to turn and face the whole in a lathe even to the segment *N*. Plate *F*, being bolted at the top of the bracket *E*, forms an outside bearing for the stud as well as a convenient means of locking the turret in position.

The locking is accomplished as follows: The lugs *U U*, fastened to the turret, carry the locking pin and handle *S*. This pin passes through either one of the slots in the plate *F* and is held firmly in the notch in the turret by means of the two coiled springs *R*, *R*. When it is required to advance the turret, the handle is grasped and held down, after which the turret revolves automatically until the locking pin snaps into the next notch. This automatic revolving of the turret is due to the tendency of the gears to constantly cause it to turn on its own axis. Of course, after one cycle of operations is completed it must be turned back by hand to its original starting point. Should the tendency of the turret to revolve be too great it may be partially checked by means of a spiral spring or by some friction device arranged to hold in one direction only. The hand wheel, at the front, is threaded on the stud and can be tightened up as an extra locking device if extreme rigidity is required. This will probably not be needed except in cases of severe work or when great accuracy is required; if not needed it can be left just slack enough to make the turret rigid and yet turn easily. Pinion *C* is provided with a bearing *D*, bolted between *E* and *F*, which serves to line up the attachment on the drill press spindle and also forms a stop, keeping the pinion *H* from striking pinion *C*, should the turret be turned past the last notch.

P, *P*, *P*, are slots for driving the chuck out from its socket and can only be operated with the turret opposite the central slot in the plate *F*. It will be seen that the hand wheel will interfere with this, but the trouble can be remedied by cutting away a portion of the rim opposite the slot.

More than three spindles might be used by increasing the diameter of the gear *G* and crowding the pinions *H* nearer

together; five or six spindles may be easily provided for without an excessive diameter of *G*, should the character of the work be such that they will not interfere with it. If the work is very light so that a sensitive drill is required, it may be obtained by substituting paper or leather faced wheels for the gears. In this case it would be necessary to provide an adjustment for the friction between the bevel wheels; and this could be easily done by making an up-and-down adjustment to the pinion *C*, on its spindle, and by making the inside bearings of pinions *H* part of the plate *N*, adjusting up and down by moving the plate in or out on dowel pins between the bolts.

Another change that might be desired is that of having all of the spindles stationary excepting the one in actual use. This could be accomplished in case of the friction drive, or in case of the gear drive if the gears are of a fine pitch, by making both the inside and outside bearing for the pinion *H* in one piece and eccentric with the holes in the plate *N* and turret, throwing this into gear by hand when any drill is wanted. A pinion put on the eccentric bushing below *N*, to mesh with a segment hanging from *E*, would throw the spindle in and out of gear as it passed by the segment. However, all of these extra refinements detract from the simplicity of the arrangement and are not advocated as necessary or desirable. FRED S. ENGLISH.

New London, Conn.

MICROMETER MEASURING INSTRUMENTS.

Editor MACHINERY:

The micrometer instruments here shown were built, in leisure hours, by Mr. A. L. Monrad, of this city, and with his consent I will illustrate and describe them, thinking that some of the readers of MACHINERY may wish to duplicate them for their own use.

Fig. 1 shows a form of micrometer that has proved very handy for measuring snap gages, and thicknesses, and can also be used as a small height gage to measure the distance from a shoulder to the base, as shown in Fig. 2. In measuring snap gages or thicknesses, the outside and inside of the measuring disks are used respectively. This instrument may also come in very handy when setting tools on the planer or shaper. As will be seen in the cut, there are two sets of graduations on the sleeve *A*, thus enabling the operator to tell at a glance what measurement is obtained from the outside or the inside of the measuring disks. Each of the disks is .10 inch thick so that the range of the micrometer is .80 and 1.00 inch for the outside and inside respectively. The details of the instrument are as follows:

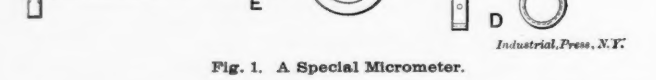


Fig. 1. A Special Micrometer.

The sleeve *A* is composed of the inside measuring disk, the graduated sleeve, and the micrometer nut combined. On the disk are two projections, *KK*, which are knurled, thus providing a grip when operating the tool. The sleeve is threaded on the inside of one end, which acts as a micrometer nut, and the outside of this same end is threaded to receive the adjusting nut *D*. The sleeve has two slots, each placed 90 degrees from the graduations, and these provide for compensating for wear. The disk part is hardened by heating in a lead bath and is finished by grinding and lapping. The barrel *B* is the same as a regular micrometer barrel and is graduated in .025 divisions. Spindle *E* combines the outside disk and the micrometer screw, and the barrel *B* fits on its end, which is tapped out to receive the speeder *C*, which serves to hold the barrel in position. The thread is $\frac{1}{4}$ inch, 40 pitch, and the disk and unthreaded parts are hardened, ground and lapped. To adjust this instrument, loosen the speeder *C* and turn the barrel until the proper adjustment is obtained. Then lock the barrel by tightening the speeder again.

Fig. 3 shows an assembled view and the details of a micrometer caliper square which, if accurately made, is equal and ofttimes preferable to the vernier caliper now so generally used.

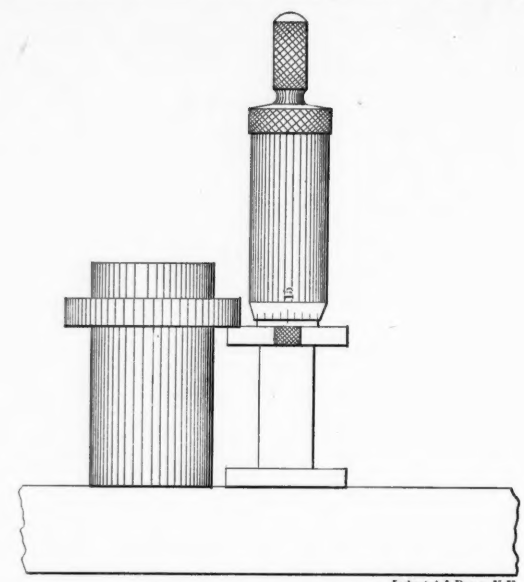


Fig. 2. One of the Uses of the Special Micrometer.

One of its advantages over the vernier is that when the measurement is taken it can be readily discerned without straining the eyes and this instrument is as easy to manipulate as the regular micrometer.

In the details, part *A*, which is the main body of the instrument, is made of tool steel, the forward or jaw end being solid with the body. This end is hardened and the jaw ground and lapped. The body is bored out and two flats milled on the outside which lighten it up and make it neat in appearance. The jaw end is counterbored out with a 45-degree counterbore to form a bearing for the forward end of the micrometer screw. A slot, $\frac{1}{8}$ inch in width, extends from the fixed jaw to the other end and in this slides the movable jaw *C*. There are 88 divisions along the side of this slot, each division being .025 inch apart, thus giving the tool a range of 2 inches for outside and 2.2 inches for inside measurements. The screw *B* is the most essential part of this tool, its construction requiring great accuracy. Its diameter is $\frac{3}{8}$ inch and it is cut with a 20 pitch thread. On its forward end fits the cone *F*, which is hardened and ground, the round part acting as the forward bearing of the screw and fitting in the 45-degree counterbored hole in the body *A*. On its other end fits the graduated barrel *D* and also the speeder *G*.

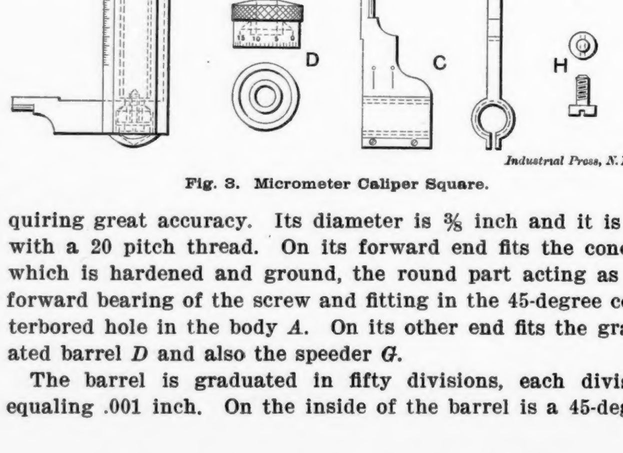


Fig. 3. Micrometer Caliper Square.

The barrel is graduated in fifty divisions, each division equaling .001 inch. On the inside of the barrel is a 45-degree

bearing which rides on the cone *M*, the cone being held stationary on the end of the body. Thus it will be seen that both front and back ends of the micrometer screw are carried in cone bearings, which give a very small point of contact, thereby causing but little friction and preventing any danger of gumming up so as to run hard. The sliding jaw *C* is made of tool steel, hardened, ground and lapped, and combined with it is the micrometer nut which is drawn to a spring temper. This nut is split and adjusted by two screws to compensate for wear. On this jaw are the two zero marks that tell at a glance the outside or inside measurement taken. The screw and washer, marked *H* and *I*, go onto the end of the micrometer screw and take up the end play. To make a neat appearance, the cap *E* is placed in the forward counterbored hole, being held in place by a tight fit. The adjustment of the tool is accomplished by loosening the speeder *G* and turning the barrel on the screw, when the adjustment is made the speeder is again tightened down and the barrel locked.

The depth gage, shown in Fig. 4, has a ½ inch movement of the rod and may be used with rods of any desired length. These have small 45-degree-on-a-side grooves cut into them at intervals of ½ inch. A small coiled spring, marked *I*, gives the rod a constant downward pressure so that, when taking a measurement, the base of the tool is placed on the piece of work and the rod always finds the bottom of the hole; then, by tightening the knurled screw *F* the rod is clamped in position and the tool may be picked up and its measurement read from the dial. The graduations on this instrument are similar to those of the vernier caliper, only they are much plainer, as a half inch movement of the rod turns the dial one complete revolution. The figures on the dial denote tenths of an inch and those on the body of the tool, thousandths; each graduation on the dial is therefore equal to 10-1000, so that to show the depth of a hole to be .373 the dial would be revolved around so that the seventh division beyond the 3 mark would be near to 0 and then by looking from the 0 mark toward the left the third graduation on the body and one on the dial would be in line, thus denoting .373.

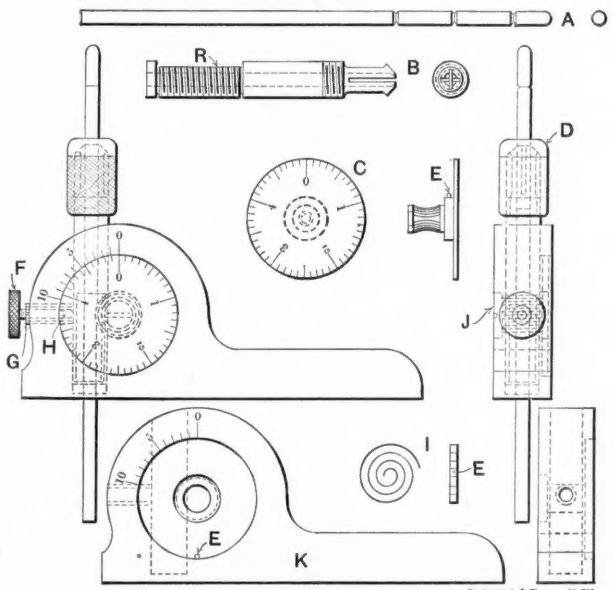


Fig. 4. A Vernier Depth Gage.

The most essential part of this tool is the threaded screw *B*, which acts as a rack, and the worm wheel, solid with the dial *C*. The upper end of the screw forms a split chuck which grips the measuring rods, while the part marked *R* is flatted off and against this portion bears the threaded sleeve *G*, which acts as a key to keep the screw in position. The sleeve is threaded, both inside and outside, and screws into the body of the tool, while the binding screw *F* fits into it and binds against a small piece of copper, marked *H*, which in turn holds the screw in position. The thread on *B* is .245 inch in diameter and is cut with a 40 pitch thread. The worm wheel which meshes into this screw is solid with the dial, as shown at *C*. It is .18 inch in diameter and requires great accuracy in cutting; it is not hobbed but the teeth, of which there are twenty, are milled with a circular cutter of the same diameter as the screw *B* plus .002 inch. The little studs, marked *EE*, on the dial and on the body *K*, hold the coiled spring in position. Very great accuracy must be attained when locating the holes, in *K*, that are to receive the screw and dial, *B* and *C*. The screw marked *J* fits into the dial, where it serves as a bearing and also holds the dial in position. The knurled cap *D* tightens the split chuck in order to hold the measuring rod firmly.

All of the tools that have been described require an accurately cut screw and, as very few lathes are capable of doing this, it may be well to illustrate an indicator for testing the accuracy of the lead screw and to explain the method in which

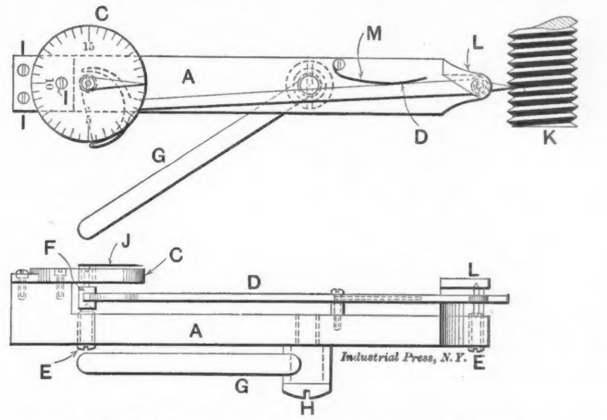


Fig. 5. Indicator for Testing Accuracy of Leadscrew.

it is used. This instrument is shown in Fig. 5, where it is applied to a test screw *K*. It consists of a body *A* on one end of which is a projection *L* to serve as the upper bearing for the pivoted lever *D*. This lever swings about a small steel pivot which can be adjusted by the screw *E*. The rear end of the lever is forked and between the prongs is passed a thread making a double turn about the pivot *F* that carries the pointer *J*. Any movement of this lever will, therefore, cause this pointer to revolve above the dial *C*. This dial has 20 divisions, each indicating one half thousandth of an inch movement of the front end of the lever, so that a total revolution of the pointer about the dial would indicate a movement of the front end of the lever of .02 inch. The screws *I*, *I*, *I*, serve to hold the dial in place on the body of the indicator while the spring *M* keeps the pointer normally at the zero mark. The indicator is held in the tool post by the arm *G*, which can be set at any angle and firmly clamped by the screw *H*.

To use the indicator, remove the screw from a micrometer which is known to be accurate and, with the aid of a brass bushing, chuck it in the lathe so that the threaded end will project. Now gear the lathe to cut 40 threads per inch and apply the indicator. When the lathe is started the point of the indicator follows along in the thread of the micrometer screw and any variation in the lead will be noted by a movement of the pointer over the dial. If, on the other hand, no movement takes place it is an indication that the pitch of the lead screw is correct.

Jos. M. Stabel.

New Haven, Conn.

* * *

What is said to be a novelty in automatic cut-off engine construction, was built some time ago by the Erie Engine Works, and that is, right and left engines connected to the same crankshaft, cranks set at 90 degrees and flywheel in the center carrying two governors, one for each engine. Some trouble was anticipated from this arrangement as it was thought that there might be interference and racing developed by the non-concurrent action of the two governors, but it is claimed that none developed. The engine was built to the order of a customer who was located in a mountainous region, making the transportation of heavy parts difficult. He wanted a 300 horse power engine and by having it built as described it was more easily transported, quicker delivery was assured and the cost was 25 per cent. less. Another advantage is that if one engine breaks down, it can be disconnected and the other run independently, developing one-half the normal power and with perfect regulation.

NOTES OF TRAVEL—THE MILLS OF THE ANCIENTS.

Editor MACHINERY:

The grinding of grain for food by the Romans was evidently accomplished by the use of a pair of millstones—one stationary and the other rotating over it, in a way similar to what was our own common practice until recent years, comparatively speaking, before the roller milling process with its pairs of slightly-grooved, cylindrical chilled-iron rolls replaced the stones.

The millstones used by the Romans did not have flat surfaces rubbing together, however, as has been the practice of recent generations. Instead of these flat rubbing or grinding surfaces, they used stones conical in form, or approximately so. The illustration—a photograph taken in October, 1902, of one of the baker shops in excavated Pompeii—shows the forms of stones used. The lower stone has a conical top, and the other is hollowed out conically both top and bottom, so that either end will fit the nether stone. The outside is shaped to conform, in a general way, with the inner cones. The walls of the shell are thicker at the waist than at the ends of the upper stone; but the taper of the grinding surfaces does not differ materially from that of the outside. The inner stone reaches up to the middle of the upper one, and is only slightly more blunt than the external appearance of the latter might seem to indicate. The upper end is a hopper into which a considerable quantity of grain may be poured.

Pompeiian Bakery, showing the Millstones.

The sets of stones are placed very near together, so near that no four-footed animals of sufficient size to turn them would have room to walk around adjacent stones at the same time. Neither is there any space nearby where the beasts could have been placed and their power transmitted to the mills. The entire region is closely built up with houses. They might have been placed above on the second floor, but appearances are against it, and it is improbable. Neither are there any indications that the energy of either wind or water was applied. Although there are numerous water pipes in the city, up to the sizes of three inches or more in diameter, there were none of any but the smaller size near any of the grinding and baking shops.

History and present indications both seem to agree fully that man power was used for the grinding. It is recorded that slaves were utilized for the purpose. In the side of each upper stone, at the waist, there are cut two rectangular recesses, diametrically opposite each other. They are apparently for the insertion of a pair of short levers or arms for turning the stone.

The comparatively light weight of the rotating stone evidently made it necessary to give the conical form to the grinding surfaces in order to secure both sufficient pressure for crushing the grain and ample area of grinding surface, to pulverize it fine enough. And it is also possible that the sloping surfaces were necessary in order to feed the grain through between the stones; for with the slow speed that a man could give, there would be no appreciable centrifugal action, which is a factor in high-speed power-driven stones, acting to throw the grain out from the center.

The mouth of the oven shows indistinctly on the left side of the picture.

FORREST R. JONES.

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ITEMS OF MECHANICAL INTEREST.

NOVEL RATCHET MECHANISM—NEW MILLING CUTTER—ELECTRIC WORM-DRIVEN PUMP—REVERSING AN ENGINE—VARIABLE SPEED DEVICE—MERCURY VALVE VAPORIZER—NODON ELECTRIC VALVE.

The *Mechanical Review* says the practice of hardening steel dates back to the remotest antiquity. Homer, Pliny, and Lucretius refer to the hardness imparted to iron taken from the forge and plunged in water. The ancient Egyptians heated meteoric iron in the forge at a temperature somewhat below the melting point until it had absorbed enough carbon from the fuel to give it the requisite hardening properties, and then fashioned their weapons and tools from the metal thus obtained.

The *Mining Reporter* quotes a German photographic journal, the *Photographisches Wochenblatt*, as recommending the use of peroxide of hydrogen for giving greater intensity of color to blueprints. It will be remembered that a blueprint is not as intense on leaving the washing water as it is after some twenty-four hours' exposure to the air, an effect assigned to oxidation. To remedy this it is suggested that a few drops of peroxide of hydrogen be added to the water, to increase the rate of oxidation. The scheme is also useful when the paper is old and gives veiled prints. In case the sensitized paper has turned a greenish blue, it should be over printed until a decided image is visible. Then a little washing soda solution should be added to the washing water but it should be used sparingly. The washing should be repeated until the whites are clear, and then the prints should be given a final wash in water to which a little peroxide of hydrogen has been added.

Magnalium, developed by Ludwig Mach, is an alloy formed of varying proportions of magnesium and aluminum. Equal parts make a light, hard, tough metal susceptible of a high polish. It is silvery white and is not oxidized by exposure to the air, neither does ammonia nor sulphuric or acetic acid harm it. But it is affected by sea water from which we infer that salt is detrimental to it, making it unsuitable for cooking utensils. The alloy has a specific gravity of from 2 to 2.5, depending on the proportions of magnesium and aluminum. It can be rolled, hammered, forged, and worked generally in the same way as any malleable metal. A valuable property is that it can be cast in very thin shapes and that it fills a mold with absolute fidelity, thus making it particularly valuable for the reproduction of ornamental designs. The price of magnalium in Germany, where it is manufactured, is about the same as copper.

The oldest steamboat plying in waters in the vicinity of New York City is the "Norwich," built in New York in 1836. Her hull is of wood, constructed by Lawrence and Sneden. The engine is of the steeple type, and was constructed by Cunningham & Hall, New York. It has a cylinder 40 inches in diameter by 10 feet stroke. The original boiler was of iron, but this, of course, has been renewed as well as parts of the machinery and hull, causing the whole to be at the present time something like the "Dutchman's breeches." The boat was built for the New York and Norwich Steamboat Company and ran for a number of years on Long Island Sound. Afterwards it was used on the Hudson, on the New York and Rondout line. Since 1850 it has been employed for towing barges and for breaking the ice in the Hudson in the winter time, which occupation has given it the name of the "Ice King." The boat is a familiar object to those who take trips up the Hudson River.

In a pamphlet upon the prevention of loss by fire, Edward Atkinson calls attention to the numerous instances where spontaneous combustion has been caused by the use of lard or ani-

mal oils instead of mineral oils, and refers especially to the danger from waste soaked in animal oils. He says:

"The spontaneous combustion of waste has been one of the principal causes of loss by fire. This danger has been almost wholly removed from cotton factories by the substitution of the mineral or so-called paraffine (para affinis) oils for lubrication, in place of animal oils, the mineral oils having no affinity for oxygen. Investigation of oil has shown that 33 per cent. of mineral oil mixed with lard oil would overcome the tendency to spontaneous combustion; also 25 per cent. mixed with sperm. But these mixtures do not serve in machine tool work. Therefore, there is still a liability to the spontaneous combustion of waste used in wiping tools in machine shops where pure lard oil is used on the cutting tools. The liability to spontaneous combustion in woolen mills has been very much reduced since methods were discovered for scouring wool treated with mixed oils partly consisting of the mineral oils."

The Standard Roller Bearing Co., Philadelphia, have sent us the record of a large thrust bearing which at that time had been in use for something over two years (798 days). The bearing was of the same general type shown in the illustration, 8 inches inside diameter, 18 inches outside diameter, and with one-inch rollers and one-inch washers. The bearing operates at 125 revolutions, and sustains a constant load of 100,000 pounds. There are 78 rollers in the bearing, each roller, therefore, supporting 1,282 pounds. In the way of an interesting calculation it is estimated that the rollers average to make 16 revolutions per revolution of the bearing, or 2,000 turns per minute for each roller. The bearing operates 16 hours a day, making 120,000 revolutions for the bearing per day and 1,920,000 for each of the rollers. The total for the 798 days amounts to 95,760,000 rotations for the bearing and 1,532,160,000 for the rollers—a pretty good record under a pressure of 100,000 pounds, or 50 tons.

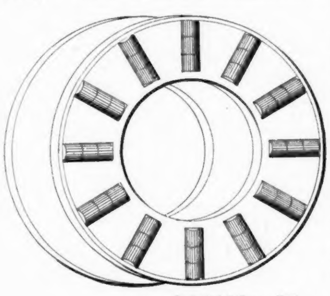

Industrial Press, N.Y.

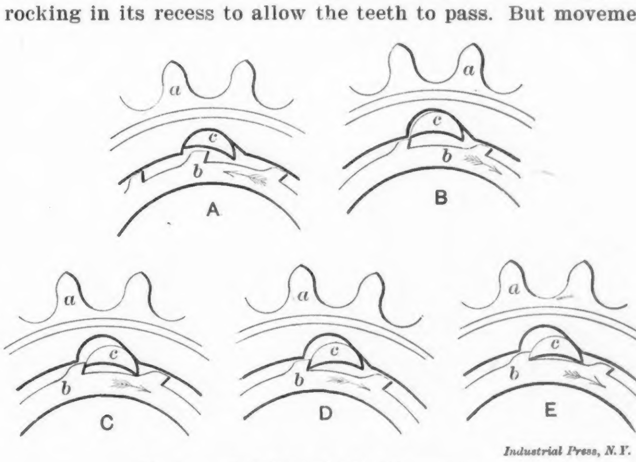
Fig. 1. Roller Thrust Bearing.

Theories have been advanced to account for the humming of telegraph and telephone wires, which are probably more satisfactory to the originators than the sound is to those who have to listen to it when the weather conditions are just right. The small boy is always firmly convinced that the wires are tingling with the messages sent; and some older people too. To stop the noise a device called the "anti-hum" is sometimes used, which is essentially the same in construction as a swivel in a chain. Rubber or some other elastic substance is placed between the bail and the pintle of the swivel and the current is conveyed around the rubber by a wire connection. The vibrations are absorbed by the rubber. The "anti-hum" is used where the wires come into depots and other offices where the din would be unbearable if something of the sort was not used. But it appears, from a statement made by a correspondent of *Science and Industry*, that the humming of telegraph and telephone wires can be prevented if the tie wires holding the line wire to the insulators are properly put up. The correspondent says that he has almost invariably found that if the ends of the tie wires are left to stand as they were after being twisted around the line wire, the line will hum; but if the tie wires are driven toward each other so as to tightly bind the line wire to the insulators there will be absolutely no humming.

Sir Samuel Wilks, writing to *Knowledge*, states that Fahrenheit's thermometer owed its beginnings to the invention of a thermometer by Newton, which was described in the Philosophical Transactions for 1701. Newton's instrument was a tube filled with linseed oil, and the starting-point of the scale was the temperature of the human body, which Newton called 12. It is worthy of notice that at this period, when numeration was based upon natural requirements, the duodecimal system was proposed for this, as it was in use for all other purposes. Newton accordingly divided the space between his datum and the freezing-point of water into 12 equal parts, and stated that the boiling-point of water would be about 30 of these degrees on the scale. Fahrenheit, when he began to work with Newton's thermometer, did not find the scale minute enough for his purposes. He therefore first doubled the number of degrees, making the scale number 24 instead of 12. Finding he could, by mixing ice and salt, obtain a temperature below freezing, Fahrenheit next adopted this for his starting-point and counted 24 degrees up to body heat, making the freezing-point 8 and calling boiling water 53. Later on he again divided his degrees into four. It will be seen that if the above figures are multiplied by four, the result is the thermometric scale called after him, which is still in use.—*Scientific American.*

NOVEL RATCHET MECHANISM.

An English concern is making a bicycle "free wheel" device which employs the simple and interesting ratchet shown diagrammatically in five positions at *A*, *B*, *C*, *D* and *E* in Fig. 2. The sprocket, which is the exterior part *a*, is recessed on its inner face for the reception of the crescent-shaped piece *c*, which acts as the pawl. The depth of the recess and the shape of the piece *c* are such that the teeth on *b* can pass freely when moving in the direction of the arrow at *A*, the piece *c* rocking in its recess to allow the teeth to pass. But movement



Industrial Press, N.Y.

Fig. 2. An English Ratchet Mechanism.

of *b* in the opposite direction as at *B*, causes a tooth to at once catch the end of *c* which, sliding along the inclined face of its recess, gradually checks the movement, and at the same time moves into full engagement with the tooth in *b*. The successive positions are indicated at *C*, *D* and *E*. No spring is necessary for the operation of the pawl, and "free wheel" movement is resisted with very little friction, being only that of the pawl *c* riding over the tops of the teeth in *b*, and practically of no account.

A NEW TYPE OF MILLING CUTTER.

A milling cutter for surfacing is the subject of a patent recently issued to the Krupps, of Essen, Germany. The flutes are made helical, as in ordinary practice, but in addition a thread of moderate pitch is cut over the surface of the teeth, making the cutter practically a hob with helical flutes. The teeth are rounded at the top, similar to a Whitworth thread section. The evident object sought is to make a surfacing cutter in which the cutting action shall more resemble that of a diamond-point lathe tool than a broad-nose finishing tool, than it does with the ordinary cutter. It is stated that experiments have shown that this scheme greatly reduces the power required for the cut and at the same time increases the efficiency of the cutter, especially when taking heavy cuts. If this is true it quite evidently demonstrates that provision in a milling cutter which permits the chips to curl easily is of considerable importance—more in fact than cutting the chips into larger pieces. It has always been a matter for reproach that the milling cutter divides the metal into so many parts that much power is wasted; but if a simple change of shape, which involves many more teeth, actually effects a reduction of nearly fifty per cent. of the power required, as it is said to do, it shows that the action of milling cutters has been somewhat misunderstood.

ELECTRIC MOTOR WORM-DRIVEN PUMP.

An excellent example of compact machine design in which rapid rotary motion is efficiently converted into comparatively slow reciprocating motion by means of worm gearing, is that of an electric pump shown in Fig. 3. It consists of the motor *E*, mounted on a base with a duplex pump, which drives the latter by means of double worm gearing and cranks. The combination of right- and left-hand worms, *A* and *A'*, driving two wormwheels, *B* and *B'*, which mesh together and

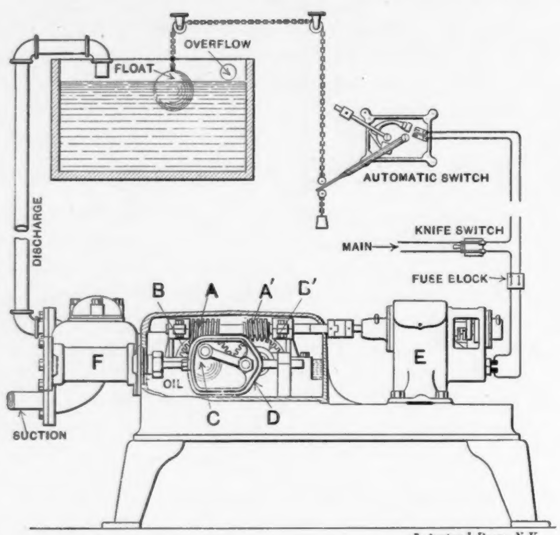


Fig. 3. Electrically-operated Worm-driven Pump.

thereby balance the thrust of the worms, is, of course, not new, but the principle is an interesting one, as is this particular application. The cranks are mounted on the shaft of the wormwheel *B*. One-half the power of the motor (less friction) is transmitted to the wormwheel *B* through the worm meshing with it; the other one-half is transmitted to it by the meshing wormwheel *B'*. By the use of the yoked extended piston rod *D* and short connecting-rod, the combination is made unusually compact. As stated, the pump is duplex, the other yoked piston rod and crank being located on the opposite side from that shown in the engraving.

REVERSING A SINGLE-VALVE ENGINE.

An item in a contemporary gives directions for reversing the motion of a single-valve engine as follows: "Turn the engine until it is on one or the other of the exact dead centers. Then mark the valve stem close to the stuffing box. Then turn the engine over until it reaches the other exact dead center; unfasten the eccentric and turn again until the mark comes to the first position. Refasten the eccentric. By using great accuracy the valve and lead will not be changed."

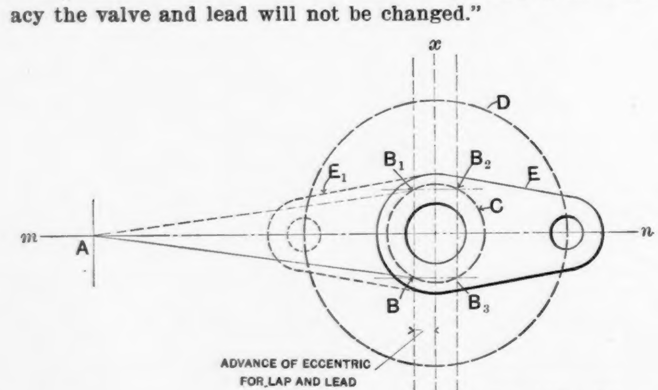


Fig. 4. Diagram Illustrating the Method of Reversing a Single Valve Engine

Unfortunately this information, put so concisely, is not correct. The accompanying sketch shows diagrammatically what the condition would be after following the directions. *E* is the crank on one dead center. The center of the eccentric for an ordinary slide valve direct-connected engine, would then be at *B* on the dotted eccentric circle line, *C*. The eccentric rod is indicated by the full line *AB*. Now when the crank is placed on the other dead center as shown by the dotted lines E_1, the center of the eccentric will be shifted just 180 degrees from its former position, or to B_2. Then loosening the eccentric and turning it on the shaft until the mark on the valve stem again shows fair at the face of the stuffing-box, as directed above, might result in placing the eccentric in either of the positions indicated by *B* and B_1. In neither of these positions will the valve be properly set. Instead of being advanced from the 90-degree line *x y* an amount equaling the lap and lead, it would be set back of the 90-degree line just that amount. Of course the valve would *not* be properly set if set in this position.

Following is a short reliable rule for reversing a single valve engine: Put the crank on either dead center *and let it stay there until through.* Scribe a line on the valve stem next to the stuffing-box. Loosen the eccentric and turn it on the shaft until the mark on the valve stem is again even with the face of the stuffing-box. Tighten the eccentric, and the engine is reversed.

It makes no difference in which direction the eccentric is turned on the shaft, but the shortest distance with an ordinary slide valve engine is away from the crank-pin, as is plainly shown on the diagram. The position of eccentric center is shown at *B* and to reverse the engine, it should be at B_1, the crank remaining in its position. The eccentric rod would then occupy the position shown by the dotted lines AB_1.

VARIABLE SPEED DEVICE.

In Fig. 5 is shown the essential principle of a British variable speed gear invented by W. N. Dumaresq and being introduced by the British Simplex Gear Co., Kensington, England. The limit of speed ratio obtainable with the device of the standard type as shown, is 4 to 1; that is, the speed of the driven shaft may be reduced to one-half that of the driving shaft, or it may be increased to two times the speed of the driving shaft. With a third drum or sprocket the speed ratio limits are as 20 to 1. The wheels *A* and *A'* are each made up

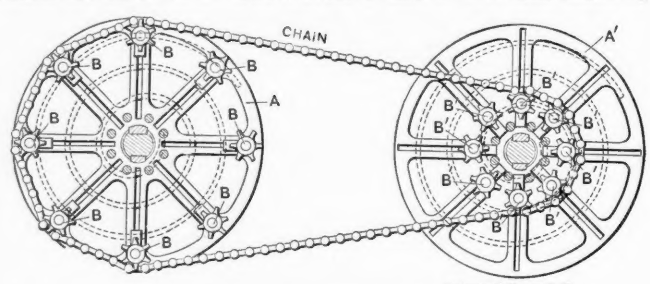


Fig. 5. Chain-driven Variable Speed Device.

of two disks or plates mounted on a shaft and carrying between them small toothed pinions, *B B B*, etc., and *B' B' B'*, etc., which are mounted on roller clutches. The bearings for the pinions are arranged to move radially in the slots shown in the plates, so that the diameter around which the chain must wrap, may be lengthened or shortened at will. Of course if the pinions of one wheel or drum are moved radially outward, those of the mating drum must be moved inwardly, and *vice versa.* The clutches, on which the small pinions are mounted, lock the pinions from moving in the direction of the pull of the chain, but offer no resistance to movement in the reverse direction. So it is evident that for such positions of the pinions that the chord lengths between adjacent pinions are not multiples of the chain link lengths, there is a constant forward turning movement of the pinions on their clutches to permit the chain engaging the teeth properly. Otherwise the chain would necessarily mount the tops of the sprocket teeth, except where the chord lengths were exact multiples of the chain link lengths. The sum of the matter is that the inventor has produced a variable sprocket wheel with provision for automatically adjusting itself to the fractional divisions of sprocket tooth space that occur when the diameter is changed.

The pinions are moved radially by means of two scroll plates for each sprocket, the spiral slots of which engage the bearings of the pinions and move them in the same manner as the jaws of a scroll chuck are operated. The manner in which the scroll plates are turned, to effect changes in diameter of driving and driven gears, is not shown. It is accomplished by the simultaneous moving in or out of two flat racks lying in slots cut in the sprocket shafts. These racks

have teeth cut across their faces at an acute angle instead of at a right angle, as ordinarily, and these teeth engage in similarly cut teeth in the bosses of the scroll plates, these to all intents and purposes being internal helical gears. The simultaneous longitudinal movement of the racks is effected by means of a screw engaging with a yoke connecting the two racks. The teeth of the racks being cut in opposite directions as are also those of the internal helical gears, the common movement of the racks turns one scroll plate in one direction and the other in the opposite direction, thus enlarging one sprocket diameter and contracting the other. The chain and its sprocket run in oil.

MERCURY VALVE VAPORIZER.

One of the drawbacks to the use of the gasoline engine for either stationary or automobile use is the fire danger that comes from the gasoline reservoir being located above the burner, so as to obtain the reliability of gravity feed. With the best mechanical valves and lever floats, as ordinarily constructed, there is always the danger of leakage, and even a leak of very small extent may suffice to flood the vaporizer and cylinder and cause a disaster which may endanger human life. So many accidents of this character have occurred that pumps are used to some extent to supply the gasoline to the vaporizer so as to avoid the danger accompanying leaky valves.

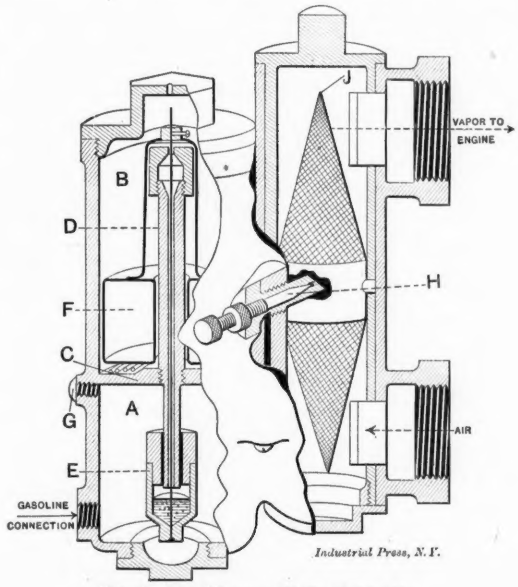


Fig. 6. The Mercury Valve Vaporizer.

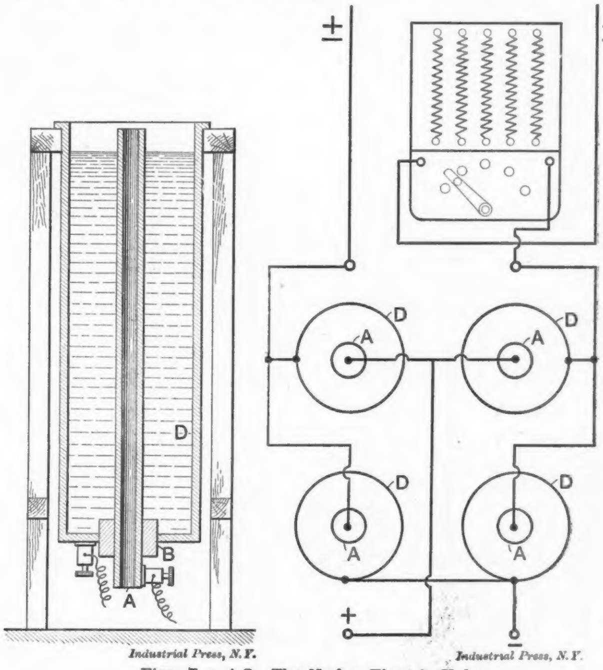
In the cut, Fig. 6, is shown a mercury valve vaporizer invented by A. W. Olds, Hartford, Conn., which is designed to afford all the benefits of gravity feed without the danger of leakage. *A* is the supply chamber separated from a float chamber *B* by a horizontal chamber. A tube *D* connects the two. At the lower end of the tube is a cup *E* containing a small quantity of mercury. This cup is supported by the float *F*, being connected to it by means of a bail and the slender wire rod passing down through the tube to the cup. Gasoline flows into the chamber *A* and because of its hydrostatic head it rises slowly but freely up through the small hole in the tube into the float chamber *B* until the chamber is partially filled and float raised sufficiently to seal the lower mouth of the tube with the mercury in the cup *E*. The pressure of the gasoline then forces a column of mercury up into the tube to such a height as will just balance the head. When this condition is reached no more gasoline can enter the float chamber until that already in it has been reduced by being drawn through the needle valve *H* into the vaporizer chamber *J*, by the slight vacuum caused by the operation of the engine. As the supply of gasoline in the float chamber lowers, the mercury cup lowers and uncovers the bottom of the tube, allowing more gasoline to bubble up through the column of mercury until it is again shut off by the float rising in the chamber.

The inventor says that every action of the vaporizer is sure, as it depends upon the omnipresent force of gravity, and of course the mercury cup always acts as a perfect valve in which wear takes no part, thus making leakage impossible.

THE NODON ELECTRIC VALVE.

A comparatively recent development in electrical engineering is the use of static rectifiers for converting alternating current into direct current without the use of moving machinery. The method generally followed where it is desirable to convert an alternating current into direct current, is to use a rotary converter. This consists of an alternating current motor mounted on the same shaft with a direct current dynamo. The power developed by the motor is converted into electric current at whatever voltage may be required. With the Hewitt and Nodon static rectifiers, moving machinery is not required. They act in the same manner as a check valve in a water pipe, which allows a liquid to be forced in one direction, but prevents flowing in the opposite direction. The same occurs with the electric valve; the impulses in one direction pass without interference, but those in the opposite direction are shut off.

The accompanying cuts from the *Electrician*, Figs. 7 and 8, show the Nodon electric valve in section and also show by diagram how the impulses in both directions are converted into direct current flowing from one common wire. This latter is, of course, highly desirable, otherwise the capacity of the central station generator would be reduced exactly one-half.



Figs. 7 and 8. The Nodon Electric Valve.

The Nodon rectifier, which is a development of the apparatus discovered by Pollak and Graetz, is extremely simple in design, and consists merely of a hollow cylinder *A*, Fig. 7, of zinc and aluminum alloy, immersed in a solution of ammonium phosphate. A containing vessel, *D*, of iron, forms the other electrode, from which *A* is insulated by the rubber plug *B*.

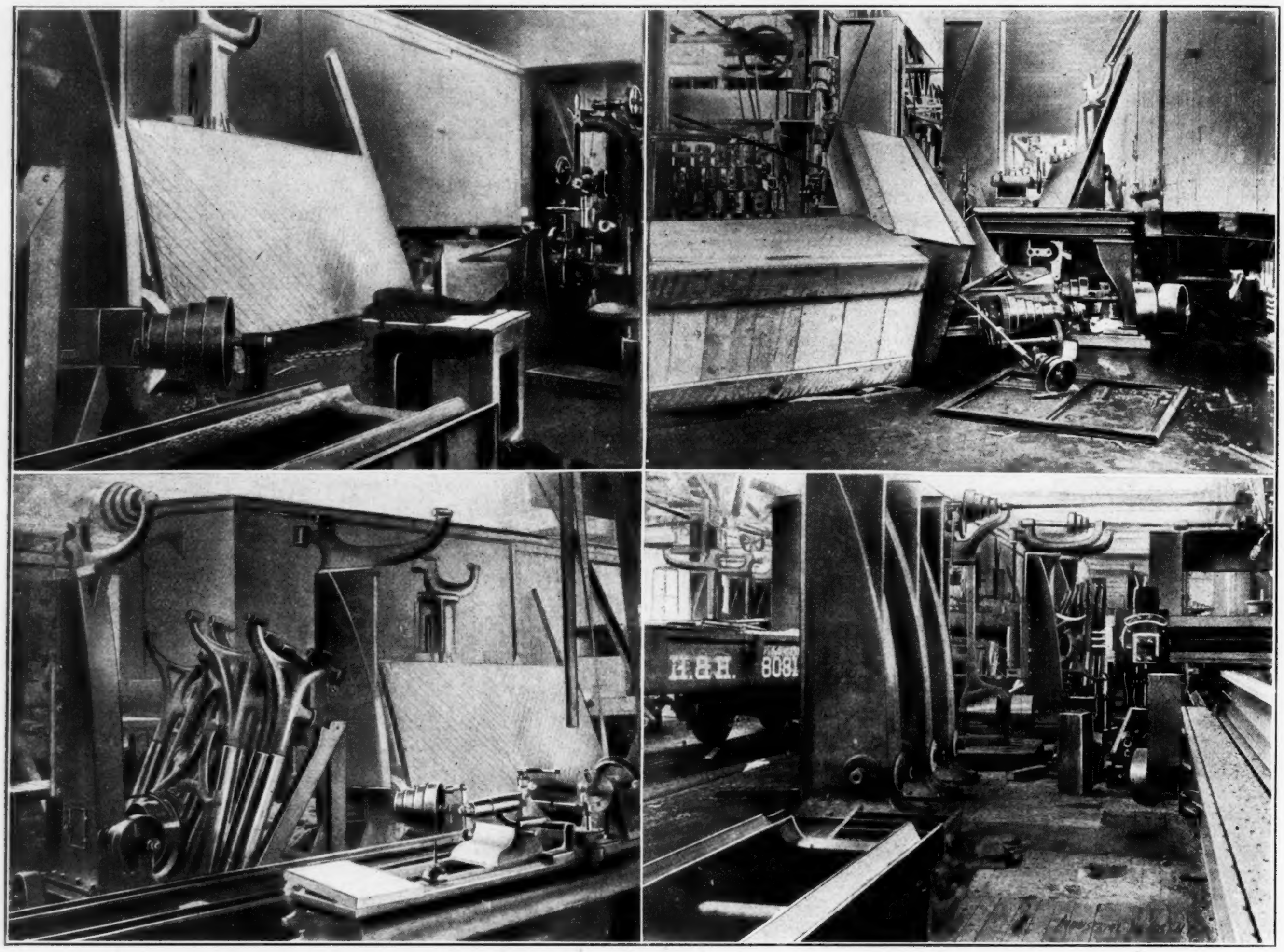
On starting the "valve," as it is called, it merely acts as a liquid resistance, and does not choke back one-half of each alternation. This, however, only lasts for a very brief time, and after a few minutes a film commences to form on the surface of the aluminum electrode. It is this film which possesses such valuable properties and permits current to pass in one direction only—i. e., from *D* to *A*. Obviously, the fact that only half the energy can be utilized is a disadvantage, but it is possible to adopt the scheme of connections shown in Fig. 8, and by using four cells, convert all, or nearly all, the alternating current into continuous current. This grouping is known as the Leo Graetz method; by following out the connections it may be seen that both semi-phases are utilized.

When used in conjunction with polyphase systems, the matter becomes rather more complicated, and it is necessary to employ a number of cells or valves equal to twice the number of wires used in distribution; for instance, six would be required on a three-wire three-phase system. Each cell may be used for rectifying current at from 50 to 140 volts, but when the voltage exceeds the latter figure, two or more cells must be connected in series, allowing 140 volts, as a maximum for each cell.

RAILROAD WRECK IN A MACHINE SHOP.

A peculiar accident occurred at the shops of the Prentice Bros. Co., Worcester, Mass., last February as the result of a train of runaway cars, and an interesting group of photographs of the resulting wreck is reproduced herewith. More than $15,000 worth of machines were damaged or ruined, but fortunately no one was seriously injured, although Supt. Harry V. Prentice and Foreman Smith barely escaped with their lives, the former receiving a bruised wrist.

The line of the New York, New Haven and Hartford Railroad runs near the Prentice shops, from which a siding extends into the main shop. The railroad is on an embankment above the level of the shop floor, making necessary a 20 per cent. grade for the siding. The accident happened early in the morning. A switch engine had just pulled two loaded cars from the shop and placed them on a siding, when seven other cars near the main line started down the incline of the shop track. It was supposed that the brakes would hold the cars, but the track was wet and they did not. When the cars started the conductor and brakemen jumped for the brakes to set them up tighter, but with no effect and were obliged to jump from the train to save themselves. The cars gained headway down the grade, and the leader, a flat car, crashed through the shop door, splintering woodwork and glass. There were 12 engine lathes and 11 upright drills standing in the shop to be shipped on these very cars. These were scattered and broken up to a greater or less extent—mostly greater—and a sensitive drill which had just been inspected was caught under the trucks of the flat car and made a subject for the scrap heap and carried over 100 feet under the cars. A pile of finished castings, weighing perhaps 75 tons, finally stopped the avalanche, but not until one of the traveling cranes had taken revenge by doing a little angling with the crane hook on its own account. The crane was at this end of the shop with its hook suspended several feet above the floor. The flat car passed under it, but the next, a box car, was fairly caught and its roof lifted off in a neat and workmanlike manner. If it had not been for the pile of castings mentioned nothing would have prevented the cars from going clear through the works and doing more extensive damage. The railroad made prompt settlement for the loss; but unfortunately the tools that were injured were on a rush order, and the delay, of course, inconvenienced the customers.



Views of the Railroad Wreck in the Machine Shop of the Prentice Bros. Co.

* * *

TO KEEP TAB ON THE ENGINEER.

A company has been organized in Milwaukee to finance an invention which the inventor claims will prevent many of the wrecks and accidents which now prove so disastrous. The instrument is styled the "railway chronograph." The machine is a small affair, but does wonderful work. An iron box about twelve inches square and three inches thick contains the instrument, which is devised to keep a record of the locomotive to which it is attached, and its engineer. The mechanism is such that it records on a tape every blast of the whistle, with its exact time and place, the speed of the train at every moment of time, the time and place any accident occurs, the speed approaching, the arrival, the delay and the departure from any station, the number of miles and amount of time consumed in switching at any station, when and where the airbrake is applied, how long the engineer is on duty any and every trip, just where the locomotive was at that moment and what it was doing at the time, and how much steam was wasted through the escape valve. The device is entirely automatic and simple to a degree. It is attached to the engine just in front of the cab and over the boiler. Mr. Sedgwick, the inventor, began his career as a telegraph operator; later he became a Methodist minister, then a professor in several colleges as a teacher of railway and mechanical engineering. He says that, despite its simplicity, the machine required ten of his best years for its perfection.

The inventor has apparently neglected one very important and desirable feature in his device, and that is means for recording the times and places where the engineer waves his hand to sundry red-headed girls along the line. That he has not provided for this vitally important record shows clearly to us that he is not thoroughly posted on all the details of railroading.

HOW AND WHY.

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

Give all details and name and address. The latter are for our own convenience and will not be published.

A subscriber asks us for information regarding the Stubbs standard screw thread. What is the form of thread and number of threads per inch for the various sizes? We have been unable to secure any data upon this subject and if any of our readers can give us the required information we should be pleased to receive it.

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19. O. P. and W. C.—Can you inform us how the covering or jacket is put on a steel shaft? We use a machine steel shaft about 11-16-inch diameter with a brass jacket 5-32-inch thick, making the outside diameter one inch. The length we use is about 6 feet; also larger sizes 12 feet long.

A.—We submit this to the readers for reply.—Editor.

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20. W. H. S.—Will you kindly inform me what is the best lubricant to use in turning copper, such as for commutators and similar electrical work?

A.—You will find the use of sweet milk to give excellent results.

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21. Inquirer.—Can you give me information as to the speed at which sewing machines operated by power in factories are arranged to run? I understand that they frequently make as many as 6,500 revolutions a minute.

A.—The Singer Manufacturing Company inform us that while machines for exhibition purposes may make as high as 6,500 revolutions a minute, the majority of sewing machines run by power in factories to-day operate at 2,000 to 2,500, although there are some high-speed machines used on special work under certain conditions that are run at 4,000 stitches per minute.

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22. E. I.—Having seen numerous discussions of the theoretical advantages possessed by each of the two systems of gearing—involute and epicycloidal—I would like to inquire which system is the better fitted for general shop use, considered from a practical, rather than a theoretical, point of view?

A.—The involute system is without doubt the best suited for all purposes and is the only system that is used to any very great extent at the present time. One of its advantages is that, while with the epicycloidal system it is necessary to have the center distances exact, with the involute system the center distances may vary quite a considerable amount from the exact dimension and the gears will yet run in a satisfactory manner. One of the greatest points in favor of the involute system, however, is the much smaller number of cutters that are required than are necessary for the epicycloidal system. To cut all numbers of teeth from 12 to rack, of a given pitch, in the involute system, but eight cutters are required; while for the same range with the epicycloidal system it would be necessary to have a set of twenty-four cutters.

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23. G. S.—Will you please inform me what is used for filling up cracks and blow holes in castings in order to smooth up the surface before painting? I wish to produce a good, smooth finish without an unreasonable expenditure of time and labor.

A.—For filling large cracks or blow holes there is a preparation called "adamant" cement. This is a metallic compound and comes in the form of a fine dry powder. For use it is mixed with water to the consistency of a thick paste and applied to the cavities with a putty knife. In a few hours it becomes as solid as the iron and is insoluble in either water or oil.

After filling the large holes with the cement the casting should be given a good heavy coat of iron "filler," which is a paint product containing paint pigments mixed with varnish liquids most suited to produce a body over the surface of the casting. This is applied with a paint brush and dries in about an hour. (The exact constituents of both the filler and cement are "trade secrets" which are not available for publication.) When the filler has become thoroughly dry it is "rubbed down" with sand paper, rotten, or pumice stone and then the machine is painted with ordinary machine paint.

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24. O. L. F.—In reference to your article on electric welding in the last number, I would like to inquire why it is that in welding tubing, or in fact cylinders or rings of any description, the current always flows through the edges of the piece being welded. Why should not at least part of the current flow around through the back of the tube or ring and so make electrical connections between the clamps or contact points in that way?

A.—We referred this inquiry to Mr. W. L. Gorton of the Standard Welding Company, who replies as follows: This question regarding the action of the current in electric welding is a common one. The best answer the writer can give is to refer your correspondent to Ohm's law. The reason why the current does not pass around the outside of the tube in any very large amount is that the resistance around the tube is so much greater than across the joint that the current flows in the lines of the least resistance and takes the shortest path. The same thing is true of any circular form that is welded. In the case of the tube, however, there is another element which is an important one. If the current should attempt to take the long passage around the circumference of the tube when the weld is started, there would be set up by this action a very strong magnetic influence in the tube. This magnetic influence tends to increase the resistance of the circuit as well as the counter electro-motive force, and for that reason, principally, in tube welding, the leakage of current around the tube is checked very considerably.

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25. W. H. W.—Will you kindly explain the difference between the centrifugal and the inertia form of steam engine governor?

A.—The centrifugal governor, of which the "fly-ball" governor is the most common example, is one in which two heavy balls are caused to rotate around the governor shaft by means of a belt driven by the crankshaft. As the engine increases in speed, and the balls revolve faster, centrifugal force causes them to fly out from the governor shaft and in so doing they operate a system of levers which close the throttle and thereby reduce the speed of the engine. If the engine is of the automatic cut-off type, the action of the levers is to hasten the point of cut-off and thereby slow down the engine to normal speed. When the tendency of the engine is to run slower than the desired speed the centrifugal force acting on the governor balls is lessened, with the result that they approach nearer to the governor shaft and operate the levers in a direction suited to open the throttle wider, or to retard the point of cut-off, so that the speed of the engine will increase. The flywheel governor, which is used largely on high-speed electrical engines, is also a type of centrifugal governor. In this case a pair of weights are pivoted within the flywheel and as the speed of the engine increases they tend to fly out from the shaft and thereby move the eccentric either around or across the shaft, or both, as the case may be, thereby changing the point of cut-off and decreasing the speed of the engine. When the speed of the engine falls below normal the weights tend to draw in toward the shaft and the movement of the eccentric which this produces causes the engine to increase in speed.

In the inertia governor, of which the Rites is the best known example, we have a weight revolving with the governor shaft and normally at the same rate. If, however, the rotation of the shaft is accelerated or retarded, the weight will continue to rotate at its normal speed and a relative motion is produced between the shaft and the weight and this motion, acting upon the eccentric or cut-off mechanism, restores the engine to its regular rate of speed. If the weight be pivoted about the center of the governor shaft, it will be seen that it will not be affected by centrifugal force but will operate only by the effect of its inertia. It may, however, be pivoted outside the center of the shaft and will then be affected to a greater or less extent by centrifugal force. By placing the pivot behind or ahead of the weight, relative to its direction of rotation, the action of the two forces may be made to assist or oppose each other, and the action of the governor may in this way be made more sensitive or more sluggish, as the case may require.

NEW TOOLS OF THE MONTH.

A RECORD OF NEW TOOLS AND APPLIANCES FOR MACHINE SHOP USE.

THE OESTERLEIN MILLING MACHINE WITH SPUR GEAR FEED MECHANISM.

The half-tone, Fig. 1, presented herewith, illustrates the new No. 24 milling machine that has just been placed on the market by the Oesterlein Machine Co., Cincinnati, Ohio. The most noticeable improvement that has been made upon this machine is the use of an all gear feed mechanism, the details of which will be clearly seen by reference to Fig. 2. In this construction spur gears are used for transmitting power from the spindle to the feed box, a duty which is ordinarily performed by bevel gears, chains, or worm gearing. These gears are of steel, cut from the solid, and are so designed that the belt on the machine cone will give way before any part of the feed mechanism breaks. This feed is a positive gear drive and consists principally of two gear boxes, an upper one which takes the power from the spindle and transmits it to the lower box, the upper box containing a sliding gear on the spindle operated by a lever to make one change of speed. The lower box contains a cone of gears, and a sliding gear by means of which the different gears may be engaged; the change is made instantly by engaging the sliding gear to any of the cone gears while the machine is running. An index plate giving the amount of travel for each gear is affixed to the feed box, so the operator can readily see what feed he is using. The feed changes are .004, .006, .008, .011, .014, .017, .020, .029, .039, .052, .066, .091 inch to one revolution of the spindle. All gears are covered by protecting guards.

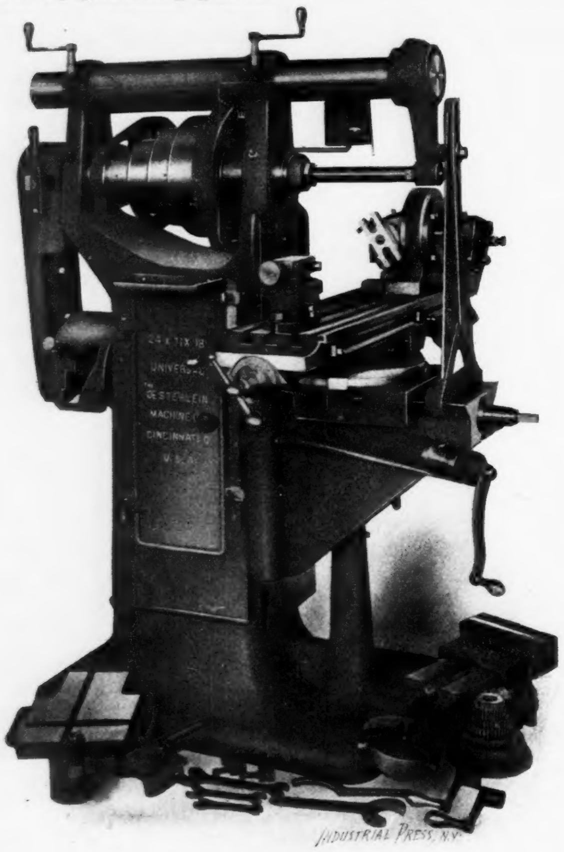


Fig. 1. Oesterlein No. 24 Milling Machine.

All screws have graduations to .001 inch. The gears in the saddle are oiled through holes in the back of the swivel. Bearings and clutches are oiled through the center table slot, by moving the table clear to the end, the oil holes coming in line with the bearings. The spindle has a hole its entire length with No. 10 B. & S. taper. The front end is threaded to allow standard cutters to be put on, and this thread is covered by a nut when not in use. The front journal is tapered and is provided with the lock nut to compensate for wear.

The cone has four steps for 3 inch belt, the diameters being 12 inches, 9¾ inches, 7½ inches, 5½ inches. The back gear ratio is 6.3 which will give, with the countershaft running 100 revolutions, a speed of 228, 130, 76, 43, 36, 20, 12, 7 revolutions per minute. The table is 40 inches long; 9 inches wide, has 3 T slots ⅝ inch wide. It has a quick return of 3 to 1 and can be operated from either end. It has screw feed, and screw has adjusting nut to compensate for wear. The table is engaged to the feed by means of a clutch on the screw, which clutch does not ride on the screw directly, but slides on a sleeve so as not to injure the screw. The whole is a very simple and positive movement without any springs, and stops the table every time within a thousandth of an inch. The table has an automatic longitudinal feed of 24 inches, automatic cross feed 7½ inches, and can be lowered 18 inches from center of spindle.

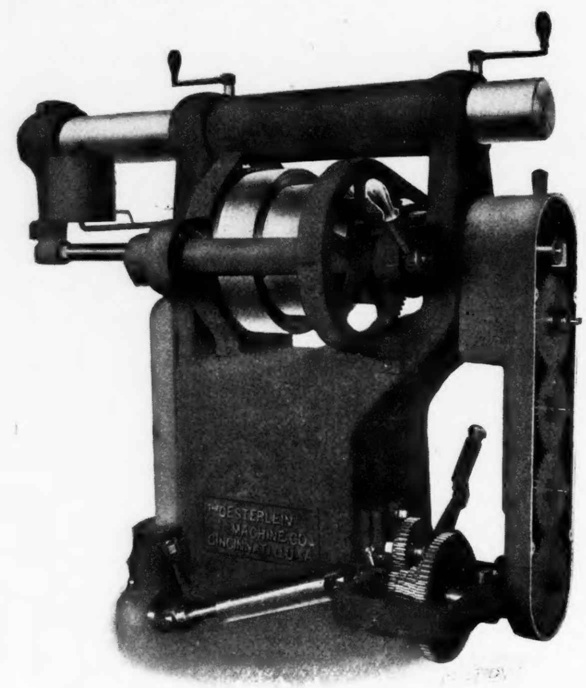


Fig. 2. Spur Gear Feed Mechanism of Oesterlein Milling Machine.

The back center is adjustable and can be lowered and raised by means of a worm and rack; the great advantage of this is the certainty that it cannot lower when once set, as is the case with centers that are merely held by friction. The dividing head is of new design, its construction allowing closer adjustment of the spindle than the old style. It is arranged to swing way round so that the work may be operated upon from either side of the head. The spindle may be clamped tight so as to release the indexing pin from all strain. It has a No. 10 B. & S. taper and swings 11 inches in diameter and 19 inches between centers. The total weight of the machine is about 2,400 pounds.

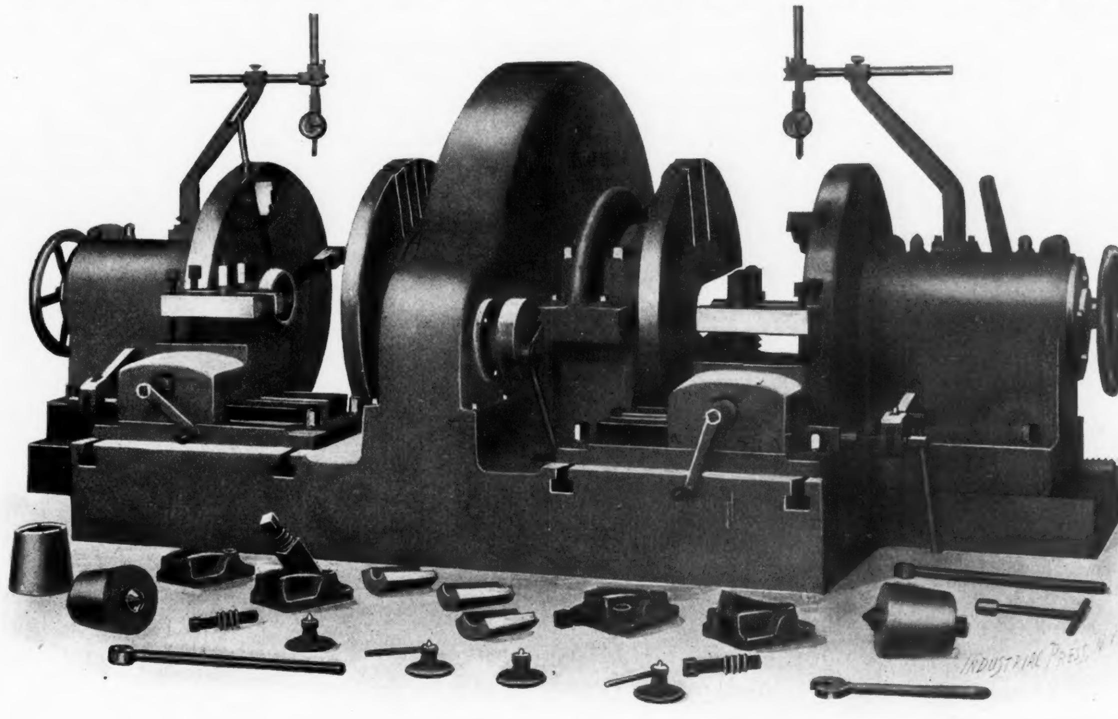
HEAVY STEEL-TIRED CARWHEEL LATHE.

The Pond branch of the Niles-Bement-Pond Co. have recently built for the Pennsylvania R. R. a number of 42-inch carwheel lathes of extraordinarily heavy design and powerful drive. A number of mechanical features make the machine an interesting tool, and the daily output of turned tires alone is calculated to attract much attention, being, we believe, unparalleled by any other carwheel lathe made for this class of work .

With the ordinary carwheel lathe made to turn wheels mounted on their axles, there is always a serious lack of stiffness of the wheels when under a heavy cut. The driving force must be applied to the sides of the wheels, in the case of those having solid center disks, and the wheels are mounted on comparatively slender axles which are only supported at the ends by pointed centers; all this contributes to lack of rigidity. There is also a tendency to force the wheels out of truth sideways at points between the driving dogs. In this lathe, self-centering chucks grasp the axle journals

and chuck jaws engage the inner periphery of the tires where they overhang the wheel centers. The wheels are driven by dogs attached to the centrally driven plates mounted on the work spindle. Power to drive the wheels is not transmitted through the outside chucks, the function of these being only to add stiffness and support to the wheels so that they may be held firmly to the heaviest cuts.

The drive is transmitted to the work spindle by means of a heavy worm meshing with a large wormwheel mounted in



Lathe for Turning Steel-tired Carwheels.

the center. The spindle and wormwheel are, of course, slotted to the center on one side to allow the wheels and axle to be placed in position from the side. The gap in the wormwheel is closed by a section bolted in place. The worm driving the wormwheel is in turn worm-driven, and in some cases an electric motor is attached directly to the second worm shaft.

Fig. 1. Farwell Stool Plate Molding Machine.

The main driving worm and the second wormwheel and worm are located in a pit beneath the floor so that the actual floor space taken up by this tool is about the same as for lighter lathes of the same class.

In regard to the output, seven pairs of 38-inch steel-tired Allen wheels have been turned in 10 hours and 35 minutes. A record of tests before us shows that one pair was turned in 1 hour 10 minutes and the longest time required for a pair was 1 hour and 55 minutes.

THE FARWELL STOOL PLATE MOLDING MACHINE.

The half-tone, Fig. 1, shows a new form of the Farwell molding machine that is designed especially for stripping-plate work where stooling is necessary. Fig. 2 shows a plan and section of the machine fitted with patterns for an external and internal gear, which are held in the circular flask *F*. The hub of the pattern *B* and the rim *C* rest firmly at all times upon the pattern frame *H*, which is securely fastened to the frame of the machine. The stripping plate *D* rests firmly upon the adjusting studs *L* and the stool plate also rests upon

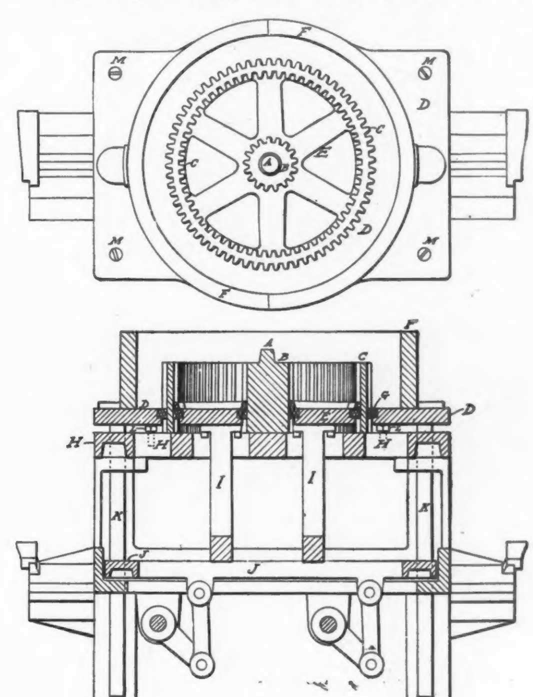


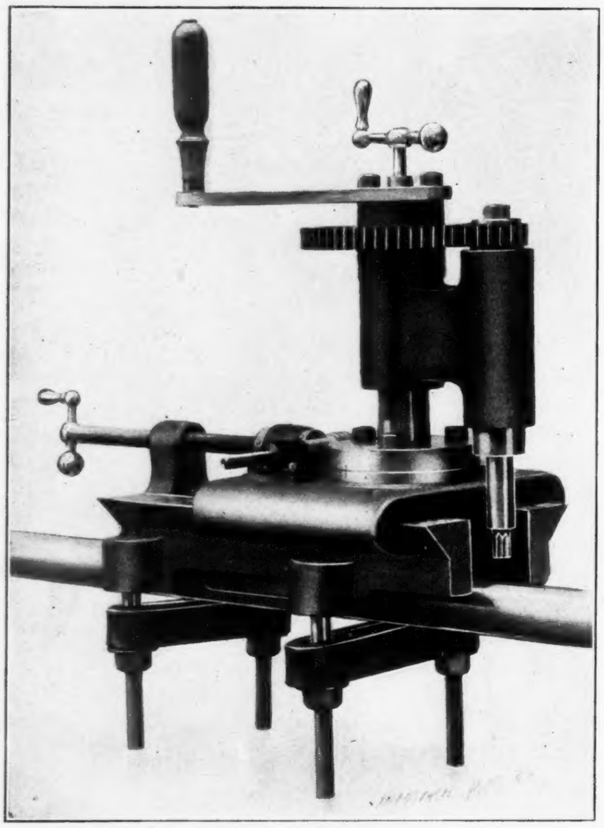
Fig. 2. Detail of Stool Plate Molding Machine.

adjusting studs, while the sand is being compressed. It will be seen that all parts which are subject to strain when the sand is compressed, have a rigid foundation and are not supported by cranks or connecting rods. Stripping plate *D* is fastened, by screws, to the rods *K*, which act as guides for both

plates and also connect the stool plate with the stripping plate. The stool E is fastened by legs I, I, to the stool plate. After sand is pressed the lift lever is operated, thereby raising the stool plate J. This also raises the stripping plate D and the stool E, and strips the patterns B and C, which remain stationary on the pattern frame H. The boss A, on the pattern, forms a core print in the sand while the spokes are fastened to the stool and follow it up when stripping the rim and hub. Babbitt metal is used where the stripping-plate meets the pattern to make a close fit. This machine is made by the Adams Co., Dubuque, Iowa.

NEW PORTABLE KEYSEATING MACHINE.

The photograph shows a new portable keyseater brought out especially for routing out the ends of milled keyseats and for truing up the sides of keyseats worn through loose gears, pulleys and couplings. The machine has a capacity for shafts up to 6 inches in diameter and will mill close up to a shoulder or flange. The bed of the machine which is clamped on the shaft, is made in V form, so that when the machine is fastened



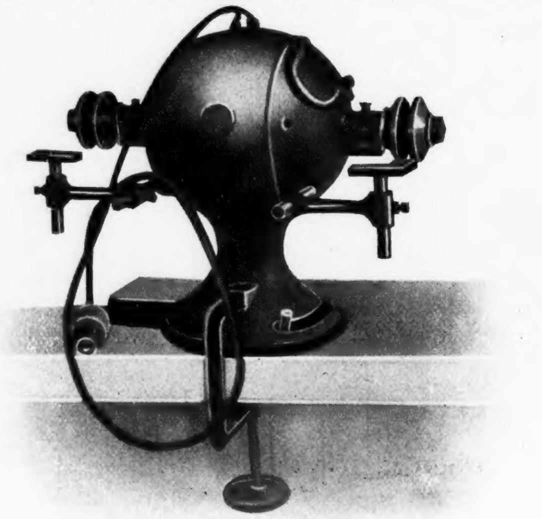
Burr Portable Keyseating Machine.

by the binders, it will be parallel with the shaft and the keyseats cut will be radial. The cutter spindle is carried by a turntable on the slide, the set-over for truing up worn keyseats being obtained by means of a worm and wheel adjustment. The part carrying the spindle is provided with a down feed screw so that the spindle can be lowered to the proper position and locked. The machine is fed by hand, the slide having a parallel travel, on the base, of 8 inches without re-setting.

In routing the ends of milled keyseats the turn table is set to the zero line on the slide, the cutter fed down until it touches the bottom of the keyseat and the slide is fed up, with the cutter rotating, until the keyseat is routed out. In truing up worn keyseats it is advisable to use the set-over to the cutter-spindle, truing up first one side of the keyseats and then the other. This machine is also adapted to truing up worn keyseats on the axles of electric cars, these keyways often becoming distorted through gears working loose. The tool is the product of John T. Burr & Son, 34 South 6th Street, Brooklyn, N. Y.

THE "ANCHOR" ELECTRICALLY-DRIVEN BENCH GRINDER

The Anchor Machine Works, Grand Rapids, Mich., has just brought out the electric bench grinder, illustrated herewith. This little grinder may be clamped upon a bench in any convenient place and is operated by the current from an incandescent lamp socket. When through grinding it can easily be put back out of the way, as it weighs only 55 pounds, and requires no other fastening than a hand clamp. The motor is inclosed in the body of the machine where it is free from dust and dirt, yet easily accessible for inspection and repair through swinging covers. It is started and stopped by means of a

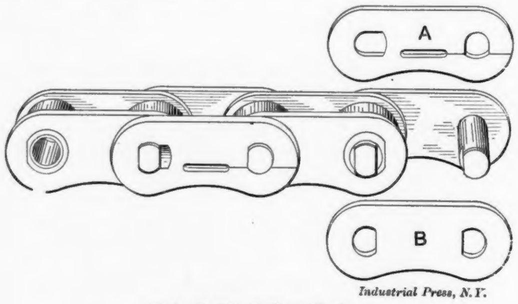


"Anchor" Electrically-driven Bench Grinder.

switch placed in the base. The spindle carries two wheels from 3 to 8 inches in diameter and up to 1 inch face. There are two rests, one for edge and the other for face grinding. The spindle runs at a speed of 3,000 revolutions per minute and the motor may be wound for a 110 or 220 volt current, as desired.

THE "WHITNEY" DETACHABLE CHAIN.

The cut presented herewith illustrates the new "Whitney" detachable roller chain which is the product of the Whitney Mfg. Co., Hartford, Conn. This chain has been adopted by one of the most prominent manufacturers of gasoline automobiles in the country and is claimed by the makers to be especially adapted to this class of work. As will be seen by the cut, it



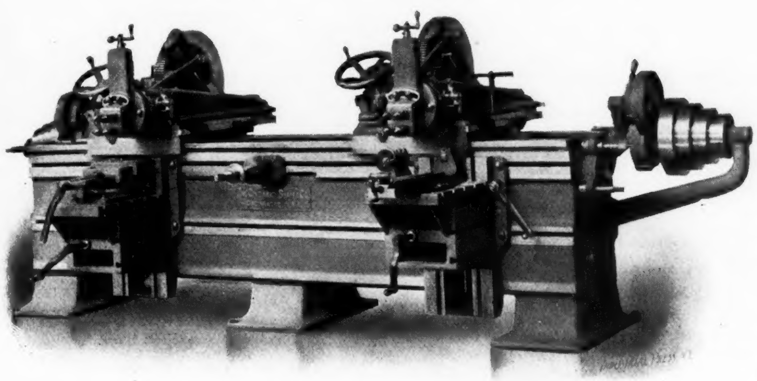
Detachable Roller Chain.

consists of a series of roller studs held together with steel side plates. A is one of the spring locking plates and B one of the regular plates. The regular plates cannot turn on the rivets on account of the irregular shape of the holes, while the locking plates prevent the regular plates from coming off. The chain is detachable at any point and can be taken apart quickly without difficulty when it is necessary to shorten it.

TWENTY-INCH TRAVERSE HEAD SHAPER.

The Cincinnati Shaper Co., Cincinnati, Ohio, have just brought out the new 20-inch traverse head shaper that is illustrated in the cut on the next page. This machine, as shown, has two heads and is back geared, although it can be supplied with a single head or the back gearing omitted, if desired. The saddles, which are gibbed to the bed by taper gibs, are operated by full length and separate lead screws so that they are not limited to working, each at its own end of the bed, but may be brought together at either end of it. They may also be moved, for coarser feed or for positioning, by means of rack and pinion, by hand or by power, and the two feeds are arranged to lock against each other so that both cannot be accidentally engaged at the same time.

The rams are operated by the Whitworth quick return motion and are provided with rack and removable pinion wrench for positioning, both in relation to the work and for length of stroke. The stroke is adjustable from 0 to 20 inches, and a scale is provided by which it is set. The feeds, both for the saddle and for the heads, are located on the saddles where most convenient to the operator. They are automatic and the amount and direction of feed can be changed while the machine is in motion. They are so arranged that feed takes place on the return stroke while operating the saddles in either direction. The down feed of the head may be obtained by

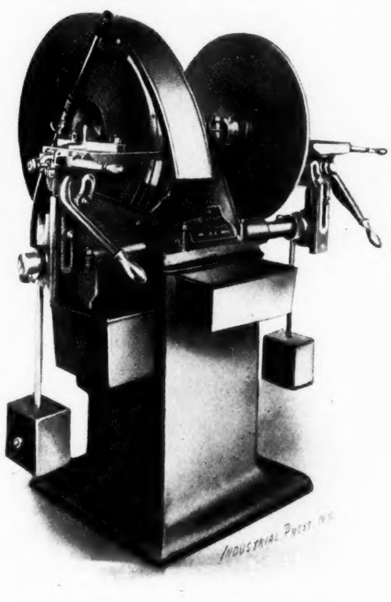


Twenty-inch Traverse Head Shaper.

hand or automatically by power and may be set from 0 to maximum, as desired. The circular feed of the head is by hand. The feed of the circular arbor is by power and is operated from the front of the machine. The tables are of box form with T slots on three sides. They are removable vertically on the aprons and horizontally with them along the bed, crank wrenches being provided, as shown, for this purpose.

COMBINATION DISK AND EMERY GRINDER.

The combination grinder, shown in the illustration herewith, consists essentially of a 23-inch disk grinder mounted upon one end of the spindle while upon the other end is an 18-inch ring of solid emery, mounted in a forged steel chuck, surrounded by a water hood and fitted with suitable pump and piping. This combination machine has been designed to



Combination Disk and Emery Grinder.

cover two requirements that were not filled by the disk grinder. In the first place the disk grinder does not work well on large surfaces of cast iron or where too much stock has to be removed as the cast iron glazes; and again, there is a class of work that will not stand the heat engendered by the disk. The water grinder on this machine covers these two points while the emery wheel has the advantage of the very rapid speed of a disk grinder, speed that it would be impossible to use with a wheel mounted in the usual way.

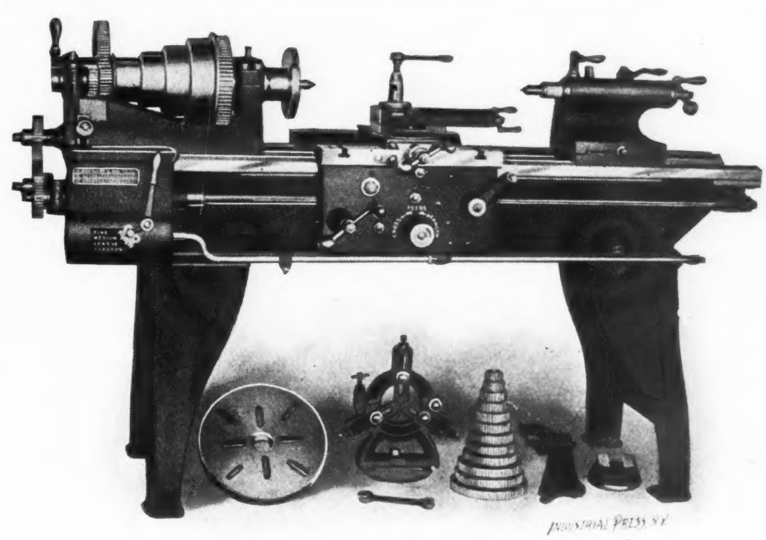
Both ends are furnished with an adjustable table which can be set at any angle and which has a rocking motion parallel with the face of the wheel. They also have a feed toward the wheel, operated by means of a lever and controlled by a micrometer screw. With these tables pieces can be sized to thickness and angles correctly ground. Furnished with the machine is a press for cementing the paper to the steel disks, of which there are two, and an 18-inch ring of emery carefully balanced in the chuck. This machine is made by the Bayldon Machine & Tool Co., Jersey City, N. J.

FOURTEEN-INCH "STAR" SCREW-CUTTING LATHE.

In the accompanying cut is shown the new 14-inch engine lathe that the Seneca Falls Mfg. Co., Seneca Falls, N. Y., have lately brought out especially for using high-speed steels with coarse feeds and deep cuts. It has an actual swing of $15\frac{1}{4}$ inches over the bed and $8\frac{7}{8}$ inches over either plain or compound rest. The bed is 6 feet long and admits of taking work 34 inches long between the centers. The spindle is hollow and carries a four-step cone for $2\frac{1}{4}$-inch belt; the ratio of back gearing is 9 to 1. The tailstock is of the curved pattern which allows the compound rest to swing around parallel with the ways and over the base of the tailstock, with room to operate feed screw handle. The tail spindle has new locking device which insures perfect alignment.

The carriage is provided with T-slots for bolting on angle plates or work and is fitted with a cam locking device, in the apron, which locks it to the bed when the cross feed is in use. This device is operated by the same lever that operates the split nut on leadscrew, so that the split nut cannot be engaged with leadscrew when the carriage is locked to the bed. The cross feed screw is graduated to read in thousandths of an inch. Either plain, compound or rise-and-fall rests are furnished, as desired. The plain and compound rests are easily interchanged, one base and tool post answering for both. The compound rest has extra long travel of $5\frac{1}{4}$ inches and is capable of fine adjustment as the base is graduated.

Power is transmitted from head spindle to leadscrew entirely by gears and is arranged with three changes of feeds, fine, medium and coarse, whose ratio is 4—2—1; these changes



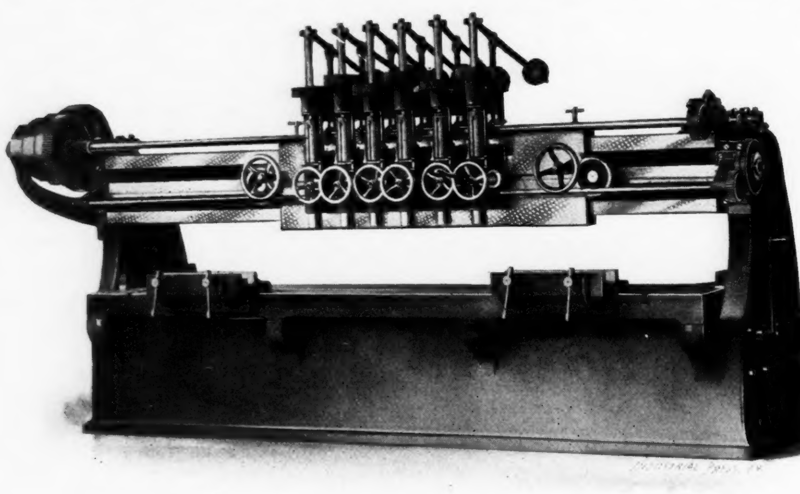
Fourteen-inch "Star" Screw-cutting Lathe.

may be instantly made while lathe is in motion, by shifting the hand lever on gear cage. An automatic stop is provided to stop carriage at any point. The friction feed, both cross and longitudinal, is thrown into operation by a single hand knob, on the apron, which operates a double friction clutch connected with the worm gear. This construction effectually prevents cross and longitudinal feeds from being put into operation at the same time. The worm, by which the worm wheel is driven, is keyed to the leadscrew which is splined so that it simply acts as a feed rod, therefore the only wear on the threads is in screw cutting.

The screw cutting range covers all standard threads, from 3 to 64, including 11½ and 27, without compounding the change gears. The leadscrew has U. S. Standard threads, and, when desired, transposing gears and the International Standard Index for cutting metric threads from 0.5 millimeter to 8 millimeters are furnished. When cutting threads the hand lever on the gear cage should point to "Threads." The automatic stop will not operate when the hand lever points to "Threads." When desired, a taper attachment will be furnished which is secured to the back of the carriage, travels with same, and is always in position ready for use. It is connected to the bed by means of a screw clamp.

MULTIPLE SPINDLE MUD RING AND FLUE SHEET DRILL.

This drill, which is shown in the half-tone herewith, is designed especially for mud ring and flue sheet drilling on locomotive work but it is also suitable for any other type of multiple drilling. The distinctive feature lies in mounting six independently fed heads, which are adjustable in their center distances on an auxiliary cross rail; this cross rail in turn being adjustable the entire length of the main cross rail. By this means a mud ring can be dropped into the two chucks shown on table, securely clamped, then without moving the work in these chucks, either one or two rows of rivet holes can be drilled the entire length at any spacing desired. All that it is necessary to do, is to set the heads on the auxiliary cross rail at any given multiple of the pitch of the rivet holes. For instance, if the rivet holes come at 2-inch centers, set the heads at 6-inch centers, and drill six holes simultaneously, then move the auxiliary cross rail carrying the six heads 2 inches and drill six more, repeating the operation the entire length of either mud ring or flue sheet. In case there are two rows of holes in the mud ring, after the first row is completed, the table would be adjusted out or in as the case might be, whatever distance is required between the two rows of holes when the operation would be repeated.



Multiple Spindle Drill for Drilling Mud Rings and Flue Sheets.

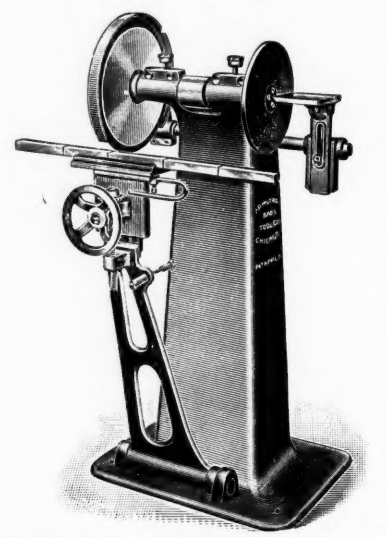
For flue sheet work, the same mode of operation would be pursued, the chucks having been first removed from the table. Length in the clear of this machine is 12 feet 4 inches between uprights; working surface of table is 12 feet 4 inches by 24 inches, having three T-slots the entire length. The table has an out or in adjustment of 24 inches, the shaft for operating this table extending out at both ends so that it can be operated from either side of the machine.

It will be clearly seen to what a variety of multiple spindle drilling such a machine can be adapted, the various adjustments provided for the heads permitting them to be accurately set at definite positions so that the machine can be used as a jig drill for accurate duplication of work. The drill is provided with four spindle speeds and three feeds, and weighs, as shown, about 17,500 pounds. The manufacturers are Foote, Burt & Co., Cleveland, O.

MACHINE FOR CUTTING OFF SELF-HARDENING STEEL.

The Armstrong Bros. Tool Co., Chicago, Ill., who are the builders of the machine here illustrated, are also manufacturers of tool holders for using self-hardening steel, and in this branch of their business they have had occasion to cut large quantities of this steel to lengths. Experience has taught that this class of steel gives best satisfaction if cut cold, although the ordinary shop practice has been to cut it hot or to break it on an anvil. The objection to the latter method is that the break is liable to be irregular, resulting not only in loss of steel but in increased grinding with waste of time and of emery wheels. After experimenting with various methods the builders adopted the machine here shown and it has given perfect satisfaction for a period of two years. The cutting is done by a disk of special grade of tool steel which is revolved at a high rate of speed. Any attempt to cut soft steel or ordinary cast steel with a disk results in a rough dragging cut, with flaring lips which bind the disk to such an extent as to reduce its speed to a point where it is ineffective, if it does not actually bend or break the disk. Owing to the peculiar nature of self-hardening steel, however, it is not affected in this manner by the cutting disk, which makes in it, even when forced hard, a clean, clear-cut incision. The periphery of the disk is coated with self-hardening steel particles, and these particles do the actual cutting.

Having had many inquiries as to their method of cutting off self-hardening steel the manufacturers of this machine have decided to place it on the market in the combination form here illustrated. The steel cutting disk is mounted on one end of the spindle while the other carries a 12-inch grinding disk, the speed at which the spindle runs being such as to give the best results for both operations. Over the cutting disk is a guard which can be easily swung back out of the way when the disk is being changed. The swinging table is provided with a length gage and is conveniently adjusted both for depth of cut and to take steel of different sizes. The grinding disk is provided with an adjustable table so located that the operator will not interfere with long bars that are being cut off by the disk.



Machine for Cutting Off Self-hardening Tool Steel.

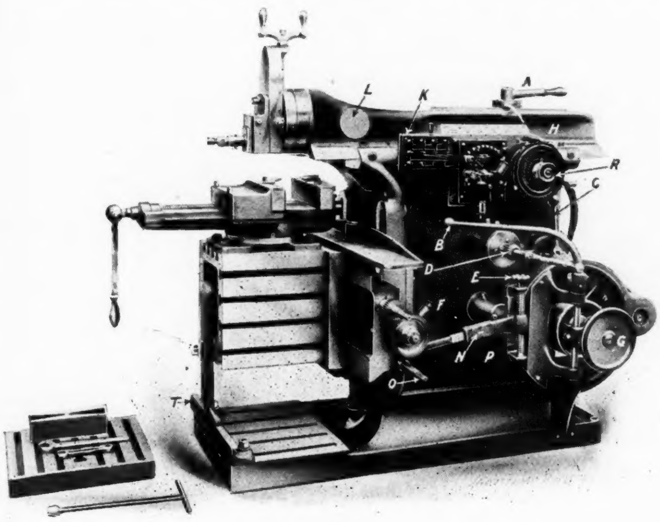
VARIABLE SPEED MOTOR-DRIVEN SHAPER.

The comparatively recent advancement in rapid machine work that has been made possible by the introduction of "high speed steels" has naturally called for changes and modifications in the design of machine tools to meet the requirements of the increased duty which they are called upon to perform. To meet this demand the Gould & Eberhardt Co., Newark, N. J., have been making a series of improvements upon their shapers which have resulted in the new motor-driven machine shown in the accompanying engraving. The builders are advocates of the individual motor application to machine tool driving, in favor of which they cite many of the advantages embodied in their new shaper which would not be possible if the machine were one of a group, or where any change of speed of the motor would affect the speed of all of the machines in the group.

In the new shaper all of the operating handles are brought within easy reach of the workman, while some important details formerly requiring hand adjustment are now made auto-

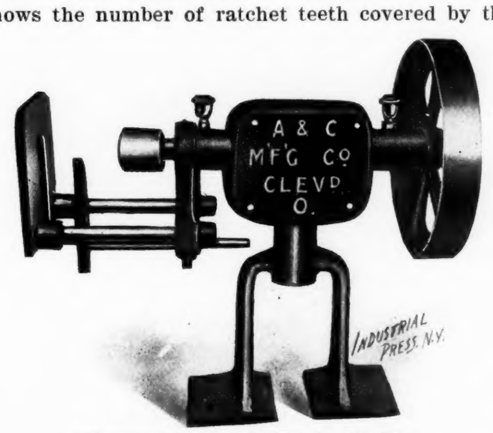
matic in operation. The position-fixing nut of the ram works on a finely toothed washer and seat, thereby avoiding slip, and is provided with an index finger reading the ram stroke in inches on the full sized scale *H*. A power down feed, not shown in the cut, can be attached to the pad *L*. This is regularly furnished on the 28-inch and 32-inch shapers and is applied to the smaller sizes when desired. The head turns through a full circle and is graduated in degrees.

The ram bearings are extended forward so as to give a long bearing in the frame when the ram is at extreme forward stroke. The vise has a large range and is provided with extra



Electrically-driven Shaper.

jaws for tapers and rounds while a pair of centers is fitted to the top of the regular jaws. The large base of the vise revolves through a full circle and is graduated in degrees. The outer end of the vise body is a steel casting thus providing a hard part of the body that can be hammered without harm. The pillar is extended in front, thereby adding substantially to the base area of the machine, and to this extension the knee-supporting truck *T* is bolted. The knee-elevating screw is operated by the shaft *O*, at the right end of the cross rail, by means of the same handle that operates the feed screw. The knee feed is by an eccentric groove in the side of the variable ram crank gear which oscillates the outside double-end rocker fork *P*, carrying a double threaded screw, and having the hand feed adjusting knob *E* at the top end. The pawl rod *N* is jointed to the feed adjusting screw nut and a scale on the side of *P* shows the number of ratchet teeth covered by the pawl



"Cleveland" Automatic Tapping Machine.

movement. The pawl rod *N* automatically adjusts itself to the different lengths demanded by different cross rail heights, by means of two stop studs which limit the pawl arm travel each way and by a screw-adjusted, leather-faced friction slip device formed in the body of the rod *N*. The friction is enough to drive the cross feed but will yield, without damage to anything, if the knee is carelessly fed to the cross rail limit. The pawl ratchet carries a spur gear which drives the feed screw pinion so that wide feeds may be had, and different gears and pinions are used to give fine or coarse feed as may be required. The ram drive is by a slotted vertical lever with a sliding block and screw-adjusted crank wrist secured by nut *D*, which is both hand and wrench tightened, so that the crank wrist shifting handle may be applied, and both hand and wrench nut tightening may be done without stopping the ram. The workman is thus enabled to vary both ram stroke and ram position without stopping the machine.

The electric-driven shapers are made for both constant and variable speed motors. The constant speed motor requires a four-step cone on the armature shaft corresponding to the cone on the shaper for obtaining the variations in speed which, together with the back gears, give eight speeds. The illustration shows the shaper with a variable speed motor and a back gear speed change operated by the lever *C*. In making the back gear change the pinion shaft is unclutched by a single motion of lever *B*, which has a brake attachment enabling the operator to stop the machine instantly, at any part of the stroke. The motor shown is wound for any single voltage, direct current and is started by the knife-switch, *K*; its speed is controlled by the rheostat knob *R*, and by the back gear change obtained through lever *C*. All of the ram stroke variations, from 100 strokes per minute single geared, to five strokes back geared, can be made inside of 10 seconds actual time. The hand-wheel *G* on the other end of the pinion shaft, gives a very convenient hand movement of the ram, either way, as may be desired by the workman in setting the tool.

THE "CLEVELAND" TAPPING MACHINE.

The A. & C. Mfg. Co., Cleveland, O., have recently placed on the market the automatic tapping machine shown in the accompanying cut. It is designed for using taps of ½-inch diameter and under, and can be fitted with any style of chuck, or tap holders of any required size can be furnished in place of the chuck. There is a sliding guide for the work so that accurate duplicate tapping can be performed. The reversing device is automatic, the machine reversing itself when the depth required has been reached by the tap. If a die be substituted for the chuck the machine can be used equally well for cutting threads.

In the February number was published an item, credited to an English publication, regarding a transparent chart designed to facilitate the making of perspective sketches and drawings, without the usually tiresome process of finding the vanishing points and locating the different parts of the drawing in proper relation. We have since learned that this useful invention is an American production, invented and sold by Mr. G. Curtis Gillespie, Architect, 7 and 9 Warren street, New York, who will be glad to answer any inquiries.

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FRESH FROM THE PRESS.

THE DERRY-COLLARD CO., 256 Broadway, New York. Booklet entitled "Turning and Boring Tapers." This is the first of a series of practical papers intended to be of use to the man in the shop. These papers are to be uniform in size and style, and it is intended to treat of only one subject in each of them, so that any particular information desired may be had without purchasing a large volume. The price of each number is twenty-five cents. No. 1 contains information on the subject above mentioned, simply and clearly treated, with numerous sketches.

MODERN MACHINE SHOP TOOLS, THEIR CONSTRUCTION, OPERATION AND MANIPULATION, by Wm. H. Van Dervoort. Published by Norman W. Henley & Son, 132 Nassau St., New York. 552 8-vo. pages. Illustrated. Price $4.

This is a volume in which the readers of MACHINERY will take a personal interest, from the fact that Prof. Van Dervoort has been a contributor to our columns of extended series of articles, upon shop practice. These articles form the basis of this book, but have been revised or rewritten, and supplemented by extensive additions.

For a long time there has been a demand for a book covering the fundamental principles of shop work. In these days it is almost impossible for a machinist to become proficient in the use of all the different tools and machines found in machine shops, and the tendency is for a machinist to work indefinitely along certain lines instead of becoming an all-around mecnanic, as formerly. We believe, therefore, there are a great many who will be glad of a reliable treatise that explains in a clear manner the simple elementary operations in using the tools—both hand and machine tools—most commonly found in shops. Such a book to be of real use should answer the questions that apprentices would ask and that a machinist would often like to ask were he not ashamed to do so.

Prof. Van Dervoort has had exactly the experience needful for completing such a task, and he has succeeded admirably. He, himself, is a practical machinist as well as a technical graduate. He has taught machine shop practice at the Michigan Agricultural College and the University of Illinois, and is now a machine shop proprietor, so that he has been able to face the subject from many sides. Naturally the numerous questions that would come from his students in teaching have been taken up and answered in the text.

This is a book of reference that would be found convenient in every machine shop. Suppose it were desired to know how to cut bevel gears, to calculate milling machine spirals or to make countershaft calculations; or to get information about tap drill sizes, the classification of files; change gear calculations; deep hole drilling; turning tapers; testing lathes, etc.; or any one of the numerous questions that

a little information might be desired upon occasionally—these pages would in all probability contain the satisfactory answer. The book will also prove a boon to students in manual training, as by studying its pages and applying its principles to the school shop, they will be able to acquire a good knowledge of shop practice. The book has numerous tables, and in addition to the chapters strictly on tools are several on fastenings, gearing, belting, shafting, and the treatment of steel. The only criticism we have to make is with regard to the illustrations. They are well chosen and illustrate the text in a satisfactory manner, but many of them are made in a way to detract from the appearance of the work. There are nearly 700 of these illustrations and we trust that in future editions the publishers may see fit to improve the appearance of the book in this respect.

STEAM POWER PLANTS, THEIR DESIGN AND CONSTRUCTION, by Henry C. Meyer, Jr. Published by the McGraw Publishing Co., 114 Liberty St., New York. 160 pages. Illustrated. Price $2.

The matter in this book was written to give information to owners or managers of manufacturing plants and buildings, requiring power installations. While it is advised in the text to employ an expert engineer to superintend line operations it frequently happens that a man of mechanical training but without specific knowledge in the matter of power station work has to make the plans and assume the responsibility. It is believed that this book will be of special value to this class and also to manufacturers who want to obtain some general knowledge of power plants from a technical standpoint. Many of the chapters in this book first appeared in the *Engineering Record*. They are well written. There are numerous illustrations taken from the pages of the *Engineering Record* which are not designed especially to illustrate the text, but are intended rather to be helpful to the reader, by the suggestions they may offer upon the subject of power installations.

NEW TRADE LITERATURE.

THE LOOP-LOCK MACHINE CO., Waltham, Mass., successors to the American Watch Tool Co. Circular giving illustrations of the Webster-Whitcomb lathe and attachments, with price list.

THE ROCHESTER MACHINE TOOL WORKS, LTD., Rochester, N. Y. Catalogue of the "Acme" engines and boilers, for natural gas, kerosene, coal, wood or coke. These are built in seven sizes. The "Acme" stationary engines are also described and illustrated.

H. W. JOHNS-MANVILLE CO., 100 William St., New York. Folder, "How to Pack Gas Engine Cylinder Heads," giving full instructions for cutting gaskets, preparing for the flange and applying the gasket so that the most efficient service may be obtained. This may be had by addressing the company in New York, or at any of their branch offices.

THE RAND DRILL CO., 128 Broadway, New York. Circular No. 2 illustrating the "Imperial" pneumatic tools manufactured by this company. It describes various sizes of "Imperial" air compressors, steam, belt or motor-driven; pneumatic tools, motor hoists, rock drills and air appliances of all kinds. Various classes of work performed by the aid of these tools are shown in the circular.

H. B. UNDERWOOD & CO., Philadelphia, Pa. Catalogue 1903 of portable tools for railway repair shops. Among these are portable boring bars for boring out locomotive cylinders, for Corliss valve seats, and for general boring; boring bars for lathe work; portable valve seat rotary planing machines; locomotive cylinder or dome facing machines, crankpin turning machines, etc. Some useful tables are also given.

PAWLING & HARNISCHFEGER, Milwaukee, Wis. Unique little folder containing a list of users of this company's cranes and hoists. The cover of this folder is only 3x4½ inches, but the list is folded accordion fashion and is (if we may be permitted to state it so) some 6 yards in length, a large number of prominent firms being represented. A list 18 feet long of customers is impressive, to say the least.

CHARLES H. BESLY & CO., 15-21 Clinton St., Chicago, Ill. Illustrated catalogue, 1903, of the Gardner grinders, the Besly band grinders, and polishing machines, spiral circles for use on Gardner grinders, Helmet oil, Badger oil cups, etc. The Gardner grinders are shown in a variety of styles and sizes, and samples of the work done on these grinders are also shown. This catalogue should prove useful to those interested in this company's products.

THE J. T. SLOCOMB CO., Providence, R. I. Catalogue and price list of machinists' tools. These include the Slocomb micrometer calipers in sizes from ½ inch to 12 inches. They also illustrate their 3-inch, 6-inch and 12-inch micrometer sets in cases, which include the various sizes of micrometers for measuring different kinds of work; and their screw thread micrometer, with pointed tip for use when cutting screw threads.

THE HENDEY MACHINE CO., Torrington, Conn. Illustrated catalogue, March, 1903, of the Hendey-Norton screw-cutting engine lathe. Those interested in this machine will do well to secure this catalogue, which contains full particulars as to its construction, and the uses to which it may be put. Sizes from 12-inch to 32-inch are shown, also four sizes of metric lathes. Pillar and traverse shapers in various sizes are also shown, and cuts appear showing the Hendey lathe, and also their shaper, arranged for motor-drive.

THE S. OBERMAYER CO., Cincinnati, Chicago and Pittsburg. Circular describing the "Peerless" follow board compounds for making follow boards for foundry use. The solid and liquid compounds are mixed until of a consistency thin enough to pour, and are cast around the pattern. After drying for 36 hours the pattern is removed and the follow board thus produced is ready for use. It becomes harder with age and the older the mixture, the better for practical use. Follow boards made up with these compounds are as strong as wood and will neither shrink nor swell; they produce perfect partings with sharp and durable edges.

THE NEW YORK BELTING & PACKING CO., LTD., New York. 1903 catalogue of rubber goods for mechanical purposes. Rubber endless belts, rubber hose for use in air drill and pneumatic tool work, for car heating, gas lighting, etc.; suction hose, fire hose, mill hose are here illustrated and described. Also a great variety of packings, such as high-pressure spiral piston and valve rod packing; hydraulic packing, for cold water and high pressure; and ring and piston packing. Rubber tubing, and a large number of rubber specialties are also manufactured by the firm.

THE NILES-BEMENT-POND CO., 136-138 Liberty St., New York. Catalogue 9x12, of horizontal boring and drilling machines. This is a very handsome work, with excellent half-tone views of the above-named machines and text printed in neat, clear type. Here are illustrated horizontal boring and drilling machines with single and with double heads; single and double head drilling, tapping and stud-inserting machines; horizontal boring, drilling and milling machines, of which 19 sizes and styles are shown, the larger sizes for the heaviest work. Then follow illustrations of the work done on these machines, such as boring spindle bearings, boring and facing headstock bearings, and parallel holes at one setting, and milling surfaces in places difficult to get at, etc. The company also build a line of smaller horizontal drilling and boring machines with spindles from 2½ to 6 inches in diameter, for smaller work.

NEW KNOWLEDGE ON BELT MANAGEMENT, issued by the Cling-Surface Mfg. Co., Buffalo, N. Y.

This is a neat little book, bound in cloth, and is a very attractive bit of advertising literature issued by the makers of the Cling-Surface preparation for belts, to extend the knowledge of Cling-Surface and of the results obtained through its use. The principal part of the book is taken up by a concisely written article, upon Cling-Surface and Belt Management, by John E. Powers. It tells all about belts, their care and treatment, what they can be depended upon to do and what Cling-Surface has done for them. It is a practical little work and is very readable.

MANUFACTURERS' NOTES.

In the description of the 34-inch Colburn vertical boring mill, published in the April issue of MACHINERY, we omitted the name of the selling agents of this machine. The Brown & Zortman Machinery Co., Pittsburg, Pa., are the exclusive selling agents.

THE WESTERN TOOL WORKS, Chicago, Ill., inform us that they expect about May 1 to double their capacity and space.

THE PEDRICK & AYER CO., Plainfield, N. J., notify us that Mr. Geo. E. Martin, formerly connected with them as superintendent of their shops, recently tendered his resignation which was accepted.

THE PATTERSON TOOL & SUPPLY CO., Dayton, O., inform us that Mr. A. J. Strong, formerly head of the tool designing department, National Cash Register Co., Dayton, is now traveling salesman for their company.

THE ROBERTSON MFG. CO., of Buffalo, N. Y., manufacturers of hardware specialties, grinding machines, mechanics' tools, etc., inform us that they have removed their works from 203 West Utica St. to 1453 Niagara St., that city.

GEORGE E. AFFLECK, 109 Liberty St., New York., dealer in all kinds of new and second-hand machine tools, has removed to 107 Liberty St., where he will occupy the entire store, and will carry about four times the previous stock.

PAWLING & HARNISCHFEGER, Milwaukee, Wis., had a fire at their works on the night of April 15, but fortunately it was confined to one building only, and they report that they were but very little handicapped, the remaining buildings being ample to take care of their work and having immediately been adjusted to do extra duty.

THE YALE & TOWNE MFG. CO., 9 Murray St., New York, are offering prizes for information from mechanics concerning Triplex chain blocks. This contest is open to all, and practical statements are the only thing required, not fine writing. For further information regarding this, we refer those interested to the advertising columns of this number.

THE BUFFALO FORGE CO., Buffalo, N. Y., announce the establishment of a new branch office at 1409 Majestic Bldg., Detroit, Mich. The offices are being equipped with every modern facility. As heretofore, the Michigan district business of the company will be in charge of Mr. H. M. Brightman.

THE ARGUTO OILLESS BEARING CO., Wayne Junction, Philadelphia, Pa., have broken ground for an addition to their present plant that will double their capacity. The large and steady increase in the demand for their bearings has made the call for larger quarters imperative.

THE MOSSBERG & GRANVILLE MFG. CO., Providence, R. I., manufacturers of presses, etc., have recently purchased the large factory formerly occupied by the Phoenix Iron Foundry, on Elm Street, Providence, and will move into it on June 1. This company's business has called for larger quarters for over a year, but it is only recently that a suitable location was found.

THE WORCESTER EMERY WHEEL CO., formerly located at 100 Exchange St., Worcester, Mass., have outgrown their old quarters and moved into their own plant on Chandler St. They have purchased the large four-story building recently occupied by the Optical Co. Mr. A. D. Putnam, formerly assistant treasurer of the Barnard, Sumner & Putnam Co., Worcester, Mass., has been made general manager.

THE NATIONAL TOOL & STAMPING CO., Fort Wayne Junction, Philadelphia, Pa., report that they have been awarded a $40,000 contract for "vending" machines by the Doremus Automatic Vending Co., New York. Mr. Stewart H. Heist is at the head of this company, which has only been equipped for business a few months. The concern will manufacture dies, tools, boiler punches and sheet metal novelties. They have a new process which they claim will harden and temper all kinds of springs, insuring a perfect product at very reasonable prices.

MISCELLANEOUS.

Advertisements in this column, 25 cents a line, ten words to a line. The money should be sent with the order.

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